A HANDBOOK

OF THE

DISEASES OF THE EYE

AND THEIR

TREATMENT

BY

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J. H. Mules

With the author's
Compliments

DISEASES OF THE EYE.

acknowledge their services to Ophthalmology in the text, and by foot-notes.

Chapter XIV., "On the Motions of the Pupil in Health and Disease," treats of a subject, which, it may be thought, should not find a place in so small a handbook as this. I have been induced to insert it by the considerations, that, so far as I know, there exists no compact and tolerably complete account of this important matter in our English medical literature; and that, it will be of use to many of my readers in after life, although I do not expect them to study it on their first or second reading of the book. For the matter contained in this chapter I am indebted to many sources, but chiefly to Leeser's work, *Die Pupillarbewegung in Physiologischer und Pathologischer Beziehung;* and to that of Raehlmann, *Ueber die neuropathologische Bedeutung der Pupillenweite.* Many of the references are taken at second-hand from the authors consulted for this chapter, when I had no means of verifying them, and are given for the convenience of any one who may wish to inquire into the subject.

TO THE STUDENT.

I take it for granted that students about to study Eye Disease will have a fair knowledge of the Anatomy and Physiology of that organ.

The portions of Ophthalmology which most students find difficult and irksome are, Accommodation and Refraction, their Anomalies, and the Theory and Use of the

Ophthalmoscope. I have, therefore, put these subjects in the beginning of the book, and I strongly advise the student to read carefully Chaps. I., II. and III. several times, either before, or immediately on joining the Ophthalmic Hospital or Department. I have endeavoured to explain the various points in these chapters in the plainest possible manner, and I should hope that no ordinary student will find any difficulty in understanding them.

The small type in Chapter II. may be passed over by the beginner, and Chapter XIV. may be left for future perusal.

Although the names of many authorities are given in the text, I do not regard it as of any importance that the student, unless he be a candidate at a prize examination, should commit them to memory.

23, Merrion Square,
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DISEASES OF THE EYE.

CHAPTER. I.

SOME ELEMENTARY OPTICS—NORMAL REFRACTION AND ACCOMMODATION—ACUTENESS OF VISION—THE ANGLE α —NUMBERING OF TRIAL LENSES AND SPECTACLE GLASSES—THE FIELD OF VISION.

SOME ELEMENTARY OPTICS.

A RAY of light (a b Fig. 1) falling on a prism (P) undergoes refraction in its passage through it (b c), and again on its exit at the opposite side (c d), in each instance the deviation being towards the base of the prism. An

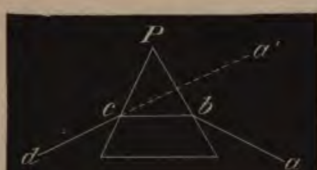


FIG. 1.

observer who is placed at d, so as to receive into his eye the emerging ray, *projects*, or thinks he sees, the object from which the ray comes at a', in a prolongation of d c.

Convex and concave lenses may be regarded as being composed of prisms; convex lenses of prisms placed with their bases together (Fig. 2, *A*); concave lenses of prisms

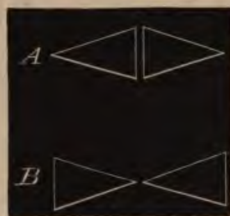


FIG. 2.

with their edges together (Fig 2, *B*). Consequently, convex lenses cause pencils of rays which pass through them to converge, while concave lenses produce divergence of the rays.

The optical centre of a lens is a point, in order to pass through which a ray of light must fall on the lens at right angles to its surface. Such a ray (*P F*, Fig. 3)

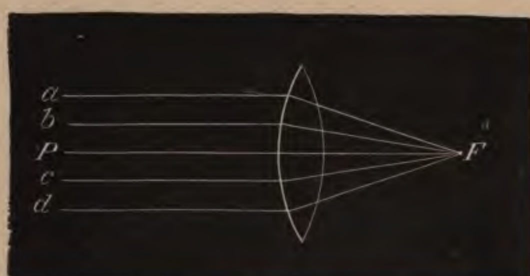


FIG. 3.

coincides with the *principal axis* of the lens, is called the *principal ray* of the pencil to which it belongs, and does

not undergo any refraction in its passage through the lens. All the other rays of the pencil undergo refraction.

Convex lenses (Fig. 3) bring parallel rays of light (*a b P c d*, Fig. 3) passing through them to a focus at a point (*F*) a certain distance on the other side. This point is called the principal focus of the lens, and the distance from it to the lens is termed the focal length of the lens. The more curved the surface of the lens, the shorter will be its focal length, and the more " powerful " the lens. Rays diverging from a light placed at *F* and falling on the lens are made parallel, when they reach its other side.

Divergent rays, *i.e.*, those coming from a near object, (*O* Fig. 4), do not meet at the principal focus of the lens

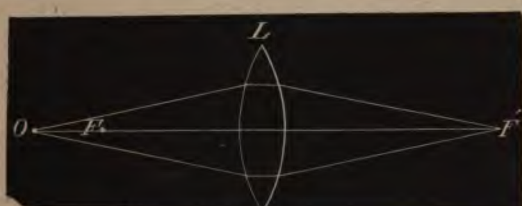


FIG. 4.

but at a point (*F′*) beyond it. This point is further from the lens, the nearer *O* is to its principal focus *F* on the other side. In like manner rays from *F′* would focus at *O*, and hence these two points are termed conjugate foci.

If the point (*O* Fig. 5) from which the rays come be nearer the lens than its principal focus (*F*), they will not

be made parallel by the lens, but will remain divergent, although not so much so as before their entrance into the

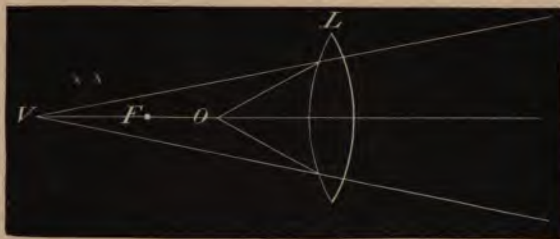


FIG. 5.

lens. If those still divergent rays be prolonged backwards they will meet at V, which would be called the virtual focus.

A concave lens (*L* Fig. 6) makes parallel rays of light

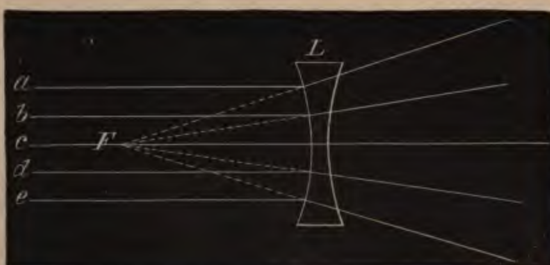


FIG. 6.

(*a b c d e*) divergent on passing through it; and, if the direction of the divergent rays be prolonged backwards, they meet at a focus (*F*), which is therefore virtual, although the principal focus of the lens. In concave lenses there are only virtual foci.

When we speak of the *image* formed by a lens, we mean the collection of foci produced by it of pencils of

rays coming from the various points of an object. For example: if *O B* (Fig. 7) be the object, and a pencil pass

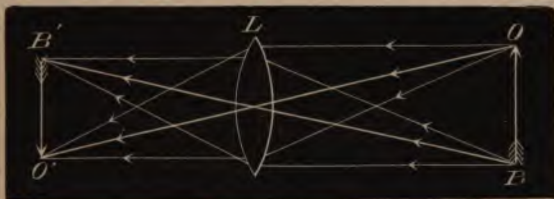


FIG. 7.

from its upper end *O* through the convex lens *L*, they will be united again at *O′*, and form there an image of the point from which they come; while the rays from *B* will form an image of that point at *B′*. Similarly, images of all the points between *O* and *B* are formed between *O′* and *B′*. Hence, the real images formed by convex lenses are inverted.

But, if the object be at the principal focus of the lens (at *F* Fig. 3), the rays on emerging at the opposite side

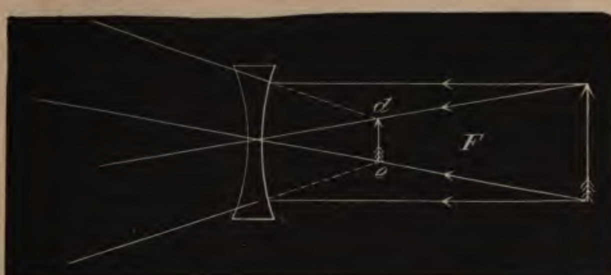


FIG. 8.

are made parallel, and the image is formed at an infinite distance.

If the object be nearer the lens (at *O* Fig. 5) than the principal focus (*F*), the image formed will be an erect enlarged virtual one (at *V*) on the same side as the object.

Concave lenses always form erect virtual images smaller than the object. In Fig. 8, the large arrow is the object, and *F* the principal focus of the lens. Rays passing through the lens from the large arrow are made more divergent, and the image is formed at a point (*d e*) found by prolongation backwards of the direction of those rays.

NORMAL REFRACTION AND ACCOMMODATION.

The eye is a dark chamber containing a series of convex refracting surfaces; namely, the cornea, and the anterior and posterior surfaces of the crystalline lens;

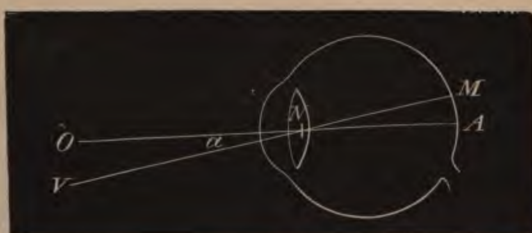


FIG. 9.

and of certain "intraocular media;" namely, the aqueous humour, the substance of the crystalline lens, and the vitreous humour; while the iris serves as a diaphragm. By aid of this apparatus distinct inverted images of external objects are formed on the retina.

The refracting media are centred on the optical axis (*O A*, Fig. 9), a line which, passing through the principal nodal point (*N*) of the eye, meets the retina at a point (*A*) slightly to the inner side of the macula lutea (M).

In treating of the eye we have to consider two sets of visual objects, viz :—distant objects, and near objects. Distant objects are those at 6 m.* and more from the eye, near objects are those closer to the eye than 6 m. For practical purposes the rays which pass through the pupil, coming from any given point of a distant object, are as good as parallel (for their divergence is so slight) when they reach the eye, and we regard them as parallel.

REFRACTION.—By the Refraction of the Eye is meant the faculty it has when at rest (*i.e.*, without an effort of

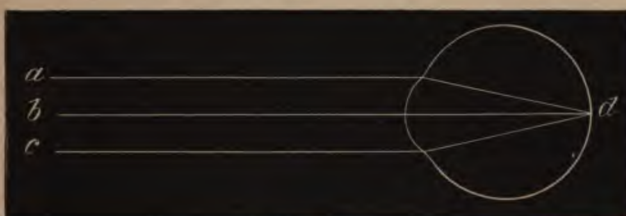


FIG. 10.

accommodation) of bringing parallel rays of light (those from distant objects) to a focus. In normal refraction, or Emmetropia (εμμετρος ωψ) as it is termed, parallel rays (*a b c*, Fig. 10) are brought to a focus (*d*) on the layer of rods and cones of the retina, and form there a distinct inverted image of the point or object from which they come.

* One metre (1 m.) = 39·5 inches.

ACCOMMODATION.—Not only can the eye see distant objects distinctly, but also near objects. The rays from any given point (*a*, Fig. 11) of a near object reach the eye with a divergence so considerable, that they could not be brought to a focus on the retina by the unaided refraction, but would converge towards a point (their conjugate focus *a′*) behind the retina, and would not form a distinct image on the latter, but merely a circle

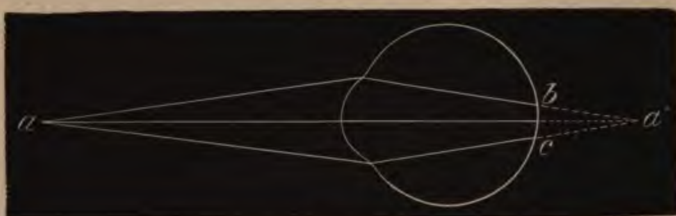


FIG. 11.

of diffusion (*b c*). An increase of refracting power in the eye is therefore necessary, in order that near objects may be distinctly seen. It is this increase in the refracting power for the purpose of near vision, which is called Accommodation.

The Mechanism of Accommodation is as follows:—The ciliary muscle contracts, thus drawing forward the choroid and ciliary processes, and relaxing the zonula of Zinn which is attached to the latter. The lens, which was flattened by the tension of the zonula, is now free to assume a more spherical shape, in response to its own elasticity. The posterior surface of the lens scarcely alters in shape, being fixed in the patellary fossa, but the anterior surface becomes more convex, thus in-

creasing its refracting power. Associated with the act of accommodation is a contraction of the pupil. The accompanying figure (Fig. 12) represents the changes which take place in accommodation, the dotted lines indicating the latter state.

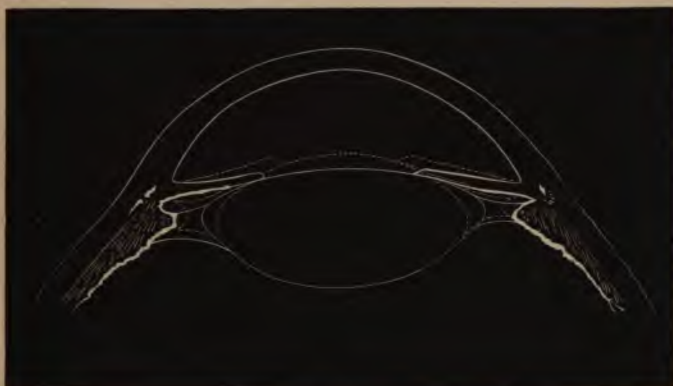


FIG. 12.

The Range of Accommodation. It is possible for the eye to see objects accurately at every distance from its Far Point (Punctum Remotum, R) up to a point only a few centimetres from the eye, called the Near Point (Punctum Proximum, P). The latter may be found by gradually approaching a book with small type close to the eye, until a position is reached at which the words and letters can no longer be distinguished. The distance between the far point and the near point is called the Range of Accommodation.

The Amplitude of Accommodation. This is the amount of accommodative effort of which the eye is

capable, *i.e.*, the effort it makes in order to adapt itself from its far point up to its near point. The amplitude of accommodation (a), therefore, is equal to the difference in the refracting power of the eye at rest (r) and when its accommodation is exerted to the utmost (p), as expressed by the formula $a = p - r$. It may be represented by that convex lens placed close in front of the eye, which would take the place of the increased convexity of the lens, or, in other words, which would give to rays coming from the nearest point of distinct vision, a direction as if they came from the farthest point. The number of this lens expresses the amplitude of accommodation in a given eye.

For example:—If in an emmetropic eye (E, Fig. 13)

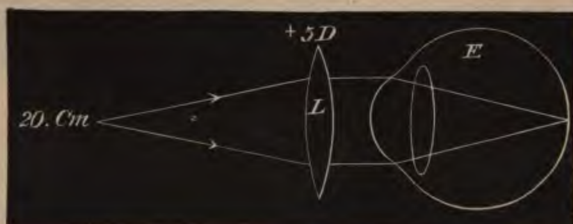


FIG. 13.

the near point be situated at 20 cm., then a convex lens (L) of 20 cm. focal length placed close to the eye (between that point and the eye) would give to rays coming from the near point a direction (*i.e.*, would make them parallel) as though they came from a distant object, and this normally refracting eye would then be enabled, by aid of its refraction alone, to bring these rays to a focus on the retina. Making use of the above equation

we find in this case that $a = 20 - r$, but r being situated at infinity we designate it by the sign 0 or ∞; therefore, $a = 20 - 0 = 20$ cm. or + 5 D lens in the metrical system, because $\frac{100}{20} = 5$ (p. 15, foot-note).

The amount of amplitude of accommodation (*i.e.*, the number of the lens which would represent it) is the same in every kind of refraction, according to the age of the individual, but in emmetropia alone is $a = p$ as above, because in it alone is $r = \infty$.

Under the head of "Anomalies of Accommodation," Chap. II., will be found Prof. Donder's diagram representing the amplitude of accommodation at different ages.

The Positive Refracting Power of the eye (p) is the power of refraction it possesses while at rest (r), plus the refracting power (a) it must add on to itself in order to be able to distinguish an object situated at its near point; therefore $p = r + a$. The positive refracting power of the eye (or the number of the + lens which would represent it) is different in each kind and degree of refraction. In emmetropia alone is $p = a$, because in it alone is $r = \infty$.

When I come to treat of the different kinds of abnormal refraction, I shall revert to the calculation of a, and the condition of p in each.

Relative Accommodation. With every degree of convergence of the visual lines, a certain effort of accommodation is associated.* Thus, if the object be situated two metres from the eye, the visual lines converge to that point, and a certain effort of accommodation is made.

* A common centre in the brain governs these motions, and also contraction of the pupil.

This effort may be increased or decreased while the object is kept distinctly in view, and the same convergence maintained. That it may be increased, is shown by the experiment of placing a weak concave glass before the eye, when it will be found that the object is still distinctly seen. And if a weak convex glass be then held before the eye, the object will also be clearly seen, showing that the accommodative effort may be lessened without affecting vision or convergence. This amplitude of accommodation for a given point of convergence of the visual lines, found by the strongest concave and strongest convex glasses with which the object can still be distinctly seen, is called the Relative Amplitude of Accommodation. That part of it which is already in use, and is represented by the convex lens, is termed the negative part, while the positive part is represented by the concave lens, and has not been brought into play. For sustained accommodation at any distance it is necessary, that the positive part of the relative amplitude of accommodation be considerable in amount.

ACUTENESS OF VISION.

In order that an eye may have good sight it is necessary, not only that the optic nerve, retina, choroid, and refracting media be healthy, but also that its refraction and accommodation be normal. When applied to by a patient on account of imperfect sight, it is our first duty, as a rule, to ascertain accurately the condition of refraction and accommodation of his eyes. Should these be abnormal, and it be found that by aid of the correcting glasses perfect vision exists, we may in general conclude

that the eye is organically sound, and that the patient's complaints are due to the defect in accommodation or refraction. If the glasses do not restore perfect vision, we must then, by the ophthalmoscope and other methods, decide the nature of the defect.

By Acuteness of Vision (V) is meant that degree of sight which an eye has after any irregularity in its refraction has been corrected, *i.e.*, while the patient wears the correcting glasses.

In order to ascertain the acuteness of vision, we place our patient with his back to the light, while facing him

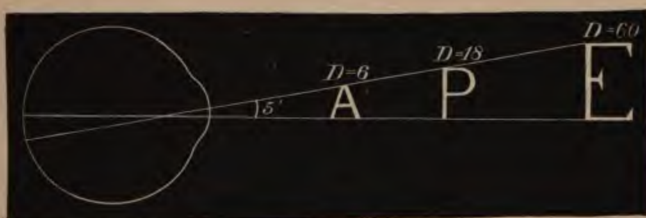


FIG. 14.

on the opposite wall, at a distance of 6 m., and in good light, hang Snellen's Test Types for distance. These types are so designed, that, at the distance at which they should be seen, they each subtend an angle of 5′ at the eye. The largest type should be seen at 60 m. (Fig. 14) by the normal eye, and the types range from this down to a size visible not further off than 6 m. If V = Acuteness of Vision, d = the distance from the eye to be tested to the test types, and D = the distance at which the type should be distinguishable, then $V = \frac{d}{D}$. For example, if d = 6 m., a distance which most rooms can command,

and if the eye see type D = 6, then $V = \frac{6}{6} = 1$, or normal V; but if at 6 m. the eye see only D = 60, which should be seen at 60 m., then $V = \frac{6}{60}$, or very imperfect vision.

The eyes must be examined separately, that one not under examination being excluded from vision by being shaded with the patient's own hand, or other suitable screen; but it must not be at all pressed on, as any pressure would dim its vision, when its turn for examination may come.

In advanced age the acuteness of vision is reduced owing to certain senile changes in the eye.

THE ANGLE *a*.

This is the angle formed by the optical axis with the visual axis (*vide* Fig. 9).

The optical axis (O A, Fig. 9), as already stated, passes through the centres of the dioptric system, including the nodal point. The visual axis (V M, Fig. 9) passes from the object looked at to the macula lutea, and in doing so must pass through the nodal point. The macula lutea (M), in emmetropic eyes, lies to the outer side of the optic axis, and consequently the anterior extremity of the visual axis lies to the inside of the optical axis as in Fig. 9.

It is by the position of the centre of the cornea and pupil, through which the optical axis passes, that we commonly judge of the position of an eye; consequently, if the angle *a* be very large, the eyes may seem to be divergent, when in truth they are both fixed on the visual object; or, if the angle be very small or even

negative, *i.e.*, the macula lutea situated to the inside of the optical axis, there may be an apparent convergence.

NUMBERING OF THE TRIAL LENSES.

Until within the last few years these lenses were numbered according to their focal length in inches. The unit of this system was a one-inch lens, which, being so very powerful, never occurred in our trial cases, while the lenses of lower power were necessarily numbered as fractions of our unit. For instance, a lens of ten inches focal length was called $\frac{1}{10}$, being ten times less powerful than the unit.

In our various calculations the use of vulgar fractions gave much trouble. This, combined with the fact that the English, French, and German inches differ slightly in length, caused it to be recommended by an International Commission of Oculists, that the metrical system be adopted for the measuring of spectacle lenses all over the world, a recommendation which by this time has been almost universally acted upon.

The lens of one metre focal length is the Dioptric Unit, or Dioptry (1 D) of the metrical system. 2 D, 3 D, 4 D, etc., indicate the number of metre lenses or dioptries contained in each of these lenses. 2 D is therefore twice as powerful a lens (its focal length only half as long) as 1 D.*

* If it be required to ascertain the focal length of a given lens divide 100 (1 metre = 100 centimetres) by the number of the lens, and the answer will give the focal length in centimetres. For example the focal length of 10 D, is $\frac{100}{10} = 10$ cm.

If the focal length of the lens be known, and it be desired to ascertain

THE FIELD OF VISION.

By the Field of Vision (F.V.) is meant the space within which, when one eye is closed, objects can be seen by its fellow, the gaze of the latter being fixed the while on some one object or point. Thus if, standing on a hill, we fix the gaze of one eye on some object on the plain below, the field of vision includes not only that object, but also many others for miles around. If the fixation object be close at hand, the field of vision will be proportionately diminished in extent.

The fixation object corresponds with the fovea centralis, and is seen by central or direct vision; the other objects in the field of vision correspond with as many different points in the more peripheral parts of the retina, and are seen by eccentric or indirect vision. Eccentric vision is of great importance for the guiding of ourselves and avoiding obstacles in our way. Its use may be realized by the experiment of looking through a small-bore cylinder (*e.g.*, a roll of music) with one eye, thus cutting off its eccentric field, while the other eye is closed.

The Dimensions of the Field of Vision may be

its dioptric number, we find it by dividing 100 cm. by the focal length. For example, if the focal length be 33 cm. then $\frac{100}{33} = 3$ D.

If it be desired to reduce a dioptric number to the inch system, divide it by 40, because although there are but 39·5 inches in a metre yet 40 is sufficiently near and is a more simple number with which to work, for example :—

$$4\text{ D} = \tfrac{4}{40} = \tfrac{1}{10};\ 3\text{ D} = \tfrac{3}{40} = \tfrac{1}{13}.$$

To change the inch system into the metrical system you multiply by 40; thus :—

$$\tfrac{1}{7} \times 40 = \tfrac{40}{7} = 5{\cdot}5\text{ D};\ \tfrac{1}{13} \times 40 = \tfrac{40}{13} = 3{\cdot}0\text{ D}.$$

measured by means of an instrument called the perimeter. This is a semicircular metal band, which revolves upon its middle point, being thus capable of describing a hemisphere in space. The arc is divided into degrees marked on it, from 0° placed at its middle point, to 90° at either extremity. At the centre of the hemisphere is situated the eye under examination, while the fixation point is placed exactly opposite in the centre of the semicircle. A small square bit of white paper, the test object, is slowly moved along the inner surface of the arc from the periphery towards the centre, until it comes into view. The horizontal, vertical, and two intermediate meridians at the least should be examined by placing the arc of the perimeter in the corresponding planes. The boundary of the field may be noted on a diaphragm or chart (Fig. 15), which represents the projection of a sphere on a plane surface.

The radii represent different meridians, which may be determined by a dial with pointer on the back of the perimeter, while the concentric circles correspond with the degrees marked on the perimeter. A pencil mark is placed on the chart at the spot corresponding to that on the perimeter at which the test object comes into view, and, when the different meridians have been examined, these marks are united by a continuous line, which then represents the outer boundary of the F.V.

The normal F.V. is not circular, but extends outwards about 95°, upwards about 53°, inwards about 47°, and downwards about 65°, as represented by the strong curve in Fig. 15. The limitation upwards and inwards is chiefly due to the projection of the supra-orbital margin and the

bridge of the nose, but also to the fact that the outer and lower parts of the retina are less practised in seeing than are the upper and inner parts, and their functions consequently less developed. The acuteness of vision diminishes progressively towards the periphery of the

FIG. 15. (*Landolt.*) Chart of F.V. of Right Eye.

field, as Landolt has shown,* two points of a certain size close together being distinguishable from each other only a short distance from the fixation point, while the

* *A Manual of Examination of the Eyes*, by E. Landolt. Translated by S. M. Burnett, p. 209.

further towards the periphery the larger must be the test objects.

The Perception of Colours in the Periphery of the Field can be examined with the perimeter, by means of bits of coloured paper 4 mm. square. It has been in this

FIG. 16. (*Landolt.*) Chart of F.V. of Left Eye.

way ascertained, that the boundaries of the power of eccentric perception for the different colours does not seem to correspond with the boundary for white light, nor do the boundaries of the different colours fall together. Examining from the periphery towards the

centre by ordinary day light, blue is the colour which can be distinguished as such most eccentrically, its field extending nearly as far as the general F.V., then come yellow, orange, red, and, with the most limited field, green. Blue, red, and green being the most important, their fields are noted in Fig. 16. Although the respective colours are distinguishable within the limits indicated, they are by no means so brilliant in hue as when seen by direct vision. Landolt,* however, has demonstrated, that every colour is recognizable up to the outer limit of the F.V. if sufficiently illuminated; so that there is, in fact, no absolute colour blindness in these parts of the retina, but merely a diminished sensitiveness to coloured light.

* *Loc. cit.*

CHAPTER II.

ABNORMAL REFRACTION AND ACCOMMODATION.

I HAVE explained what is meant by Normal Refraction or Emmetropia. We recognize three different forms of Abnormal Refraction, or Ametropia. 1. Hypermetropia, (ὑπερ.μετρον.ωψ) in which the principal focus of parallel rays of light lies behind the retina. 2. Myopia, (μυειν.ωψ) or Short Sight, in which the principal focus of such rays lies in front of the retina. 3. Astigmatism, in which the refraction of the eye in its different meridians is different.

HYPERMETROPIA.

In a large proportion of cases, this form of Ametropia is due to an arrest of development of the globe of the eye in its antero-posterior axis, the eyeball being rendered too short from before backwards. It may also depend upon deficient refracting power in the dioptric media.

Parallel rays of light falling into the hypermetropic eye (*E*, Fig. 17) do not meet on the retina, but converge towards a point (*c*) situated behind it. Consequently, these rays do not form on the retina a distinct image of the object looked at, but produce there a circle of

diffusion (*d e*) merely, a blurred representation of the object.

It is evident, therefore, that a hypermetropic eye, in order to see distant objects distinctly, must either make

FIG. 17.

an effort of accommodation, or be assisted by a convex lens.

Similarly, as the refracting media of the hypermetropic eye are not powerful enough to bring parallel rays to a focus on the retina, so they are insufficient to render

FIG. 18.

parallel those rays (*b a*, Fig. 18) which emerge from its fundus, and they therefore pass out divergent from the eye.

Determination of the Degree of Hypermetropia. In order to correct hypermetropia, a convex glass must be

placed before the eye to supplement its power of refraction. Parallel rays in passing through this glass, will be made somewhat convergent before entering the eye; and the refracting media will then be enabled, without aid from the accommodation, to impart to those rays sufficient additional convergence to bring them to a focus on the retina. The higher the hypermetropia, *i.e.*, the shorter the antero-posterior axis of the eyeball, the stronger must the correcting glass be. *The strongest convex glass with which a hypermetropic eye can see distant objects (the test-types) most distinctly, is the glass which corrects its hypermetropia, and is the measure of the latter.* If a glass a single number higher than the exact measure of the defect be placed before the eye, vision again becomes indistinct; because the rays are then brought to a focus in front of the retina, and a circle of diffusion is formed on the latter. The eye, in fact, is put by such a glass in a condition of myopia.

The degree of the hypermetropia is indicated, as

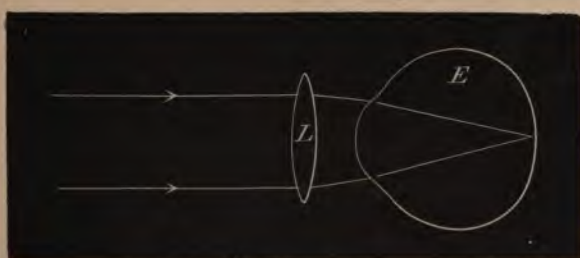


FIG. 19.

has been said, by the number of the lens which corrects it. Thus, if the number of the glass L (Fig. 19),

required to correct the hypermetropia of the eye E, be 2·0D, we say this eye is hypermetropic two dioptries, or has a hypermetropia of two dioptries (H = 2·0D).

The presence and degree of hypermetropia may also be determined by the ophthalmoscope.

Amplitude of Accommodation in Hypermetropia.—When at rest the refraction of the hypermetropic eye is deficient, consequently r must be negative ($-r$), and the amplitude of accommodation must include the power required to adapt the eye to infinity, therefore :—

$$a = p - (-r) = p + r.$$

For example :—If the punctum proximum of a hypermetropic eye of 5 D be at 30 cm., what is the amplitude of accommodation? 5 D ($= r$) is necessary in order to make him emmetropic, and to accommodate the emmetropic eye to 30 cm. 3·25 D ($\frac{100}{30} = 3·25$) is required. Hence $a = 3·25 + 5 = 8·25$ D.

Positive Refracting Power of the Eye in Hypermetropia.—In this form of ametropia there is a loss of part of the accommodative power in adapting the eye for its Far Point. For example, if the amplitude of accommodation of a hypermetropic eye of 5 D be 9 D, at what distance does the punctum proximum lie? 5 D of these 9 D are required to accommodate the eye for distant vision, therefore only 4 D remain for near vision, and, consequently, the near point will be at ($\frac{100}{4} =$) 25 cm. Therefore in Hypermetropia $p = a - r$.

The Angle α in Hypermetropia.—In hypermetropia, as in emme-

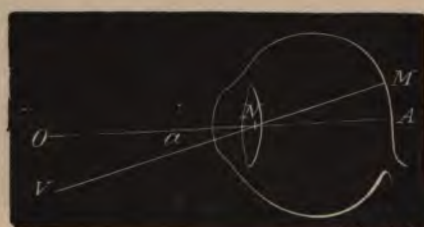


FIG. 20.

tropia, the cornea is cut to the inside of its axis by the visual line; but in hypermetropia the angle which the visual line forms with the axis of the

cornea is very much greater owing to the shortness of the eyeball, and the effect is to increase the distance between the macula lutea and the optic axis (*vide* Fig. 20). Consequently, in extreme cases, when the visual lines of a hypermetropic individual are directed to an object, the axes of the corneæ may seem to diverge, and thus the appearance of a divergent strabismus will be given.

The effects of the constant and excessive demand upon the accommodation in hypermetropia are chiefly these :—

1. **Cramp of the Ciliary Muscle.** Its persistently maintained contraction frequently gives rise to a tonic cramp of this muscle. This spasm is not, or may be only partially relaxed, when the correcting convex glass is held before the eye; and, consequently, the whole or part of the hypermetropia may be masked by the cramp. That part of the hypermetropia which is thus masked is called latent (Hl), while the part which is revealed by the convex glass is called manifest (Hm.). The entire hypermetropia is made up of the latent and manifest H ($H = Hm + Hl$).

If the cramp be excessive, parallel rays may be kept convergent on the retina by it alone, and vision may be made worse rather than better by even a weak convex glass held before the eye, the latter seeming then to be emmetropic. In this case we say that the whole hypermetropia is latent.

Or, in extreme cases of accommodative spasm, parallel rays may be united in front of the retina, and the eye made apparently myopic. Serious errors might therefore arise if this cramp were overlooked, as it is very apt to be in the examination with the trial lenses. When it is present in a high degree, the patient cannot maintain a sustained view of an object at any distance

without suffering pain in and about the eyes. It is frequently the reason why perfect acuteness of vision is not obtained by aid of the trial lenses, and the surgeon must be careful not to be led into an error of diagnosis by it. Examination with the ophthalmoscope, or paralysis of accommodation with atropine, will enable him to avoid mistakes.

In order to relieve this cramp the ciliary muscle must be paralysed by a solution of atropine freely instilled; and it will often be necessary to keep the accommodation paralysed for some days, and to commence the use of the correcting spectacles before the effect of the atropine begins to wear off. In this way a recurrence of the spasm may be often prevented.

2. **Accommodative Asthenopia.** In looking at distant objects the accommodation of the normal eye is at perfect rest, and does not come into play until the object is approached close (within 6 m.) to the eye. But even for distant objects the hypermetropic eye must accommodate; and having for those distances used up part of its accommodative energy, it has for near objects actually less at disposition than the normal eye. Hence we find that hypermetropic people often complain of inability to sustain accommodative efforts for near objects for any length of time. After reading, sewing, etc., for a short time, a sensation of pressure in the eyes, and of weight above and around them come on, and the words or stitches become indistinct and cannot be distinguished. The work must then be interrupted, and after a few minutes rest can be resumed, but must soon again be given up. After a Sunday's rest the patient is often

able to get on better than on the previous Saturday. These symptoms depend simply upon inability of the ciliary muscle to perform the excessive demands made upon it.

Accommodative Asthenopia, (α priv. σθενος power, ωψ eye,) as this group of symptoms is called, often appears suddenly during or after illness. The explanation of this is that, although hypermetropia had always existed, yet in health the ciliary muscle was equal to the great efforts required of it, but in sickness it shared the debility of the system in general. To relieve accommodative asthenopia we have merely to prescribe those lenses for near work which correct the hypermetropia, and by this means to place the eyes in the position of emmetropic eyes.

3. **Internal, or Convergent Concomitant Strabismus.** This will be treated of in the chapter on the Motions of the Eyeballs and their Derangements. (Chap. XXI.).

Myopia, or Shortsight.

This form of ametropia is due, in a vast majority of cases, to the antero-posterior axis of the eyeball being too long, and hence, its refracting media not being propor-

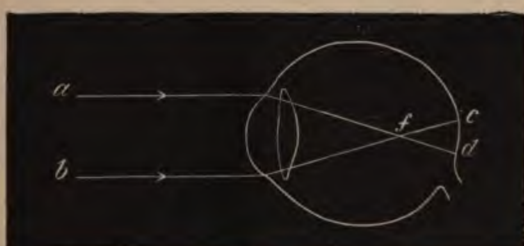


Fig. 21.

tionately diminished in power, parallel rays of light (*a b*, Fig. 21) are not brought to a focus on the retina, but in front of it (at *f*), and form on the retina circles of diffusion (*c d*).

Myopia may also be caused by abnormally high refracting power in the crystalline lens, as in spasm of the ciliary muscle, and in some cases of commencing cataract; also by conical cornea.

Similarly as the refracting media of the myopic eye are too powerful, and consequently bring parallel rays to a focus in front of the retina, so also they are more than powerful enough to render parallel rays which pass out

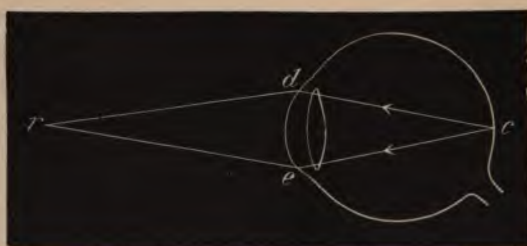


FIG. 22.

from the fundus of the eye, and therefore these rays (*c e* and *c d*, Fig. 22), pass out convergent from the eye, and meet at *r*.

According as an object desired to be seen is brought closer to the eye, the divergence of rays passing from it into the eye increases, until a point is reached where this divergence is such, that after passing through the refracting media the rays are no longer too convergent, but just sufficiently so to meet in a focus on the retina.

This point is identical with that one (r Fig. 22) of which we have just spoken, where rays coming out from the fundus meet. It is the *punctum remotum* of the myopic eye. In order, therefore, that the short-sighted eye may be able to see distant objects, it is necessary that the parallel rays coming from those objects should be given such a divergence before they pass into the eye, as though they came from this *punctum remotum*. This can readily be effected by placing the suitable concave lens in front of the eye, and the number of this glass will indicate the degree of the myopia, *i.e.*, how many dioptries the refracting power of the eye is in excess of an emmetropic eye. The focal length of the correcting glass corresponds, of course, with the distance of the *punctum remotum* from the eye, provided the glass be held close to the cornea. The focus of the glass and the *punctum remotum* of the eye are then identical, and therefore parallel rays after passing through the glass will have a divergence as though they came from this point, and will form an exact image of the object from which they come on the retina.

For example :—If the *punctum remotum* (Fig. 23) be

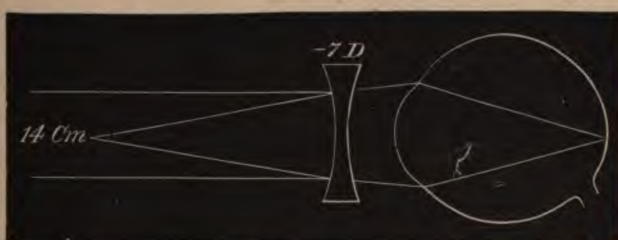


FIG. 23.

situated at 14 cm. from the eye, then the number of the

correcting lens will be 7 D, because the focal distance of this lens is 14 cm. ($\frac{100}{14} = 7$). In practice, however, we cannot hold the glass so close to the cornea, and therefore we must subtract the distance between it and the cornea from the focal distance of the required lens. In the above case, suppose the distance from cornea to glass be 4 cm., the required lens will be 10 D ($\frac{100}{10} = 10$).

Determination of the Degree of Myopia. The degree or amount of myopia may be determined either by the ophthalmoscope, or experimentally by means of the trial lenses.

By the latter method, examining each eye separately, we find the correcting glass by placing our patient as directed in the section on Acuteness of Vision. A weak concave trial glass is then held before the eye under examination, and higher numbers are gradually proceeded to, until the glass is reached which gives the eye the best distinguishing power for the types. We often find that there are several glasses, with each of which the patient can see equally well. *The weakest of these is the measure of his myopia.* When a higher glass is used the eye still sees well, but it does so only by an effort of accommodation, and the glass employed represents not merely the myopia present, but also this accommodative effort. No more serious mistake can be made than the choosing of too strong concave glasses for a myopic individual, as will be seen further on.

The following Table (Landolt) indicates in millimetres for each degree of ametropia the increase in length of the myopic eye, and the shortening of the hypermetropic eye as compared with the emmetropic eye, the length of the latter being taken at 22·824 mm. It is of great practical value

for the estimation by the ophthalmoscope of the depth of a glaucomatous excavation, or the height of a swelling of the papilla or other elevation on the fundus oculi :—

Degree of Ametropia.	Myopia.		Hypermetropia.	
	Length of Eye.	Too long by :	Length of Eye.	Too short by :
0	22·824	0	22·824	0
0·5	22·98	0·16	22·67	0·16
1	23·14	0·32	22·51	0·31
1·5	23·31	0·49	22·35	0·47
2	23·48	0·66	22·20	0·62
2·5	23·65	0·83	22·05	0·77
3	23·83	1·01	21·90	0·92
3·5	24·01	1·19	21·76	1·06
4	24·19	1·37	21·61	1·21
4·5	24·37	1·55	21·47	1·35
5	24·56	1·74	21·32	1·50
5·5	24·75	1·93	21·20	1 62
6	24·95	2·13	21·06	1·76
6·5	25·14	2·32	20·92	1·90
7	25·34	2·52	20·80	2·03
7·5	25·55	2·73	20·66	2·16
8	25·75	2·93	20·54	2·28
8·5	25·96	3·14	20·41	2·41
9	26·17	3·35	20·29	2·53
9·5	26·40	3·58	20·16	2·66
10	26·62	3·80	20·04	2·78
10·5	26·85	4·03	19·92	2·90
11	27·08	4·26	19·80	3·02
12	27·55	4·73	19·57	3·25
13	28·05	5·23	19·35	3·47
14	28·56	5·74	19·13	3·39
15	29·10	6·28	18·91	3·91
16	29·65	6·83	18·71	4·11
17	30·23	7·41	18·50	4·32
18	30·85	8·03	18·30	4·52
19	31·47	8·65	18·11	4·71
20	32·13	9·31	17·92	4·90

The Amplitude of Accommodation in Myopia. The myopic eye has an excess of refractive power as compared with the emmetropic eye, therefore in calculating its amplitude of accommodation this excess must be subtracted from the positive refractive power (p) which would be

required to adapt the emmetropic eye to the same *punctum proximum;* or, in other words, the myopic eye has need of less accommodative power than the emmetropic eye, because even at rest it is adapted for a distance for which the emmetropic eye has to accommodate; hence in myopia :—

$$a = p - r$$

For example, a myopic person of 10 D who can accommodate up to 8 cm. ($p = \frac{100}{8} = 12$ D) has an amplitude of accommodation of $12 - 10 = 2$ D.

The Positive Refracting Power in Myopia. This is made up of the myopia and of the amplitude of accommodation—

$$p = a + r$$

For example, an eye with My. 3 D and an amplitude of accommodation of 6 D has its *punctum proximum* at 11 cm., because $6 + 3 = 9$ D ($\frac{100}{9} = 11$ cm.).

The Angle a in Myopia. In myopia, owing to the length of the eyeball, the cornea is cut much closer to its centre by the visual line than in emmetropia, or these two lines may coincide, or the cornea may even be cut to the inside of its centre by the visual line (*vide* Fig. 24).

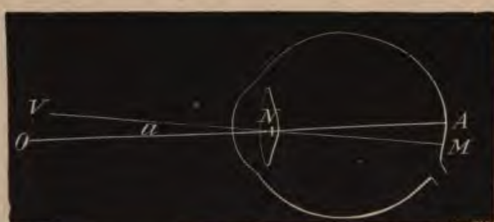


FIG. 24.

In any of these cases, but especially in the latter, the effect will be that of an apparent convergent strabismus.

Myopia generally first shows itself from the eighth to the tenth year, and is apt to increase, especially during the early years of puberty. Its progressive increase is encouraged by use of the eye for near work, such as

reading, sewing, drawing, etc., and is due to a further elongation of the antero-posterior optic axis.

Many short-sighted people half close their eyes when endeavouring to distinguish distant objects; in order that the rays may be prevented, so far as possible, from passing through peripheral parts of the crystalline lens, which would increase the circles of diffusion. This habit it is which has given the name of myopia (μυάω, ὤψ) to the condition.

Progressive Myopia frequently becomes complicated with Organic Disease, viz.:—1. *Posterior Staphyloma.* This condition is recognized by the ophthalmoscope as a white crescent at the outer side of the optic papilla. Owing to bulging of the eyeball the choroid becomes atrophied at this place, and admits of the white sclerotic being seen. The staphyloma sometimes extends all round the optic papilla, and by stretching of the retina in these extreme cases, its functions may become deranged, and, in consequence, the blind spot increased in size.

2. *Choroidal Degeneration in the Neighbourhood of the Macula Lutea.* This should always be carefully looked for, as the region of the yellow spot is very liable to disease in bad cases of progressive myopia. The disease seems to begin in the choroid, giving the appearance of small cracks or fissures which later on develop into a patch of choroidal atrophy. The retina at the spot becomes disorganized, and very serious disturbance of vision is the result, the patient being disabled from reading.

3. *Hæmorrhage in the Retina at the Yellow Spot* may occur, causing similar visual defects, and when the

hæmorrhage becomes absorbed the macula lutea may not recover its function, owing to the delicate retinal tissue having been seriously damaged. Yet we often meet with cases of this kind which do regain their former vision.

4. *Detachment of the Retina.* This is a frequent and most serious complication of progressive myopia. It will be fully considered in the chapter on Diseases of the Retina. (Chap. XVIII.)

5. *Opacities in the Vitreous Humour.* These often accompany the choroidal alterations.

Insufficiency of the Internal Recti Muscles is another anomaly which we find very commonly associated with progressive myopia; but it can hardly be regarded as an organic disease, or as a result of progressive myopia. It may more properly be looked upon as a concomitant congenital irregularity, and, perhaps, as one of the causes of the progressive nature of myopia. It will be fully discussed in Chapter XXI.

The Management of Myopia. The great danger of myopia being its progressive increase, with consequent or attendant organic disease, its management is one of our most important and difficult tasks, especially in these days of high-pressure education. Many cases of myopia are not progressive and cause no anxiety; others are periodically progressive; and again, others are continuously or absolutely progressive. In the periodically progressive form the age of puberty is usually the time of greatest increase and greatest danger, the myopia often becoming stationary later on. In the absolutely progressive cases the increase goes on rapidly until after puberty, and then more slowly, but it usually leads to

considerable loss of vision unless the greatest care be taken.

In the progressive forms, close approximation of the eyes to the work, meaning convergence of the visual lines and accommodative effort, as also everything which tends to cause congestion of the eyes and head, are what we have to try to prevent. In order that these patients may not be obliged to approach close to their work, they should occupy themselves with large and not with minute objects, and only by good light. When possible (*vide infra*) such spectacles should be prescribed for them as will enable them to read at a distance of 25 to 30 cm. They should pause to rest for some minutes occasionally during a spell of work, while the number of working hours in the day should be restricted. The action of the bowels should be regulated, the feet kept warm, and all excessive bodily exertion avoided, so that congestion of the head and eyes may be prevented. Where posterior staphyloma, hæmorrhages at the macula lutea, or opacities in the vitreous humour, are present, Heurteloup's artificial leech applied to the temple, mild purgatives, and complete rest of the eyes, with the use of atropine for some weeks to immobilize the ciliary muscle are to be ordered. If the choroidal changes be very marked, small doses of the perchloride of mercury are indicated. The eyes should be protected from light by blue or smoked protection spectacles, this latter precaution being especially necessary during the use of atropine. Insufficiency of the internal recti should be corrected by prisms or by operation.

The correction of the myopia by suitable glasses is an

important and difficult matter. In some cases of slight myopia (2·5 D and less) in young patients with good amplitude of accommodation the correcting glasses may be prescribed to be worn constantly for near as well as for distant objects, and thus the patient is placed in the position of an emmetrope. In other cases, where the error of refraction is not excessive and the eye is organically healthy, the whole defect may be corrected for distant vision, if the individual be warned not to use his glasses for near work, lest he should strain his accommodation. In high degrees of myopia strong glasses may be given for distant vision, but it is wise to give them 1 D or 1·5 D less than the full correction, so that all danger of accommodative effort may be avoided. In these same cases, provided there be no ophthalmoscopic changes or only some of minor significance, and if the vision be good, such a glass may be given as will enable the patient to read at 25 to 30 cm. This glass may be found, by subtracting from the number of the glass representing the degree of the myopia (say 7 D) the lens whose focal length corresponds to the distance (say 30 cm.) required (this here would be 3·25 D, because $\frac{100}{30} = 3{\cdot}25$, and then $7{\cdot}0 - 3{\cdot}25 = 3{\cdot}75$ D, the glass required). By aid of such glasses this myope can read at a distance much more favourable for the convergence of his optic axes and for the erect position of his head; but there is a danger associated with their use, namely:—that if the patient approach his book closer than the prescribed distance, he does away with the advantage he should gain from them, and, by necessitating an effort of accommodation, turns them to a serious source of danger for the eye.

Patients in whom the acuteness of vision is much lowered are liable to approach their work in this way, in order to obtain larger retinal images, the more so as the concave glasses diminish the size of the images, and in such cases it is better not to give glasses for near work. It is often necessary to provide patients with spectacles which will enable them to use their eyes for some special purpose at a given distance, *e.g.*, the pianoforte, painting, &c., and these can be found as above explained.

Astigmatism.

This is a compound form of ametropia, due to the cornea being more curved in one meridian than in another, similarly as the back of the bowl of a spoon is more convex from side to side than from heel to point.

The directions of the greatest and least curvations of the cornea are always at right angles to each other, and usually fall precisely in the vertical and horizontal meridians, the meridian of greatest curvature being most frequently the vertical. The result of this is, that a pencil of rays falling into the eye, instead of meeting at a common focus, is irregularly refracted, those rays passing through the vertical meridian of the cornea being brought to a focus much earlier than those which fall through its horizontal meridian; and, consequently, at the focus of the former the latter rays form a horizontal streak of light. The intermediate or oblique meridians will probably be of regularly intermediate refracting power.

The interval between the foci of the two principal meri-

dians is called the Focal Interval, and is a measure of the astigmatism.

The accompanying diagram (Fig. 25), after Donders, will assist in the understanding of the course of a pencil of rays after they have passed through an astigmatic cornea, those rays belonging to the horizontal and vertical meridians being chiefly considered.

At A neither vertical (v, v′) nor horizontal (h, h′) rays have yet been united at their foci, but the vertical rays are the nearest to their focus; and, therefore, the appearance which the pencil of rays would give, if caught here on an

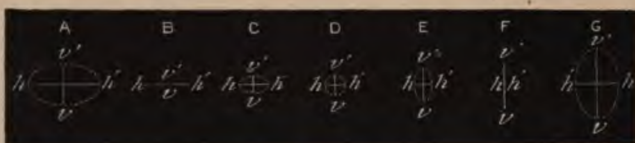


FIG. 25.

intercepting screen, is an oval with its long axis horizontal. At B the vertical rays have met at their focus, but the horizontal rays not as yet at theirs, and the result is therefore a horizontal straight line. At C the vertical rays are diverging again from their focus, and the horizontal rays have still not come to theirs. At D the same conditions exist, only a little further on, where the one set of rays is diverging, the other still converging, but each at the same angle, hence the shape of the figure is round. At E the horizontal rays have met and the result is a vertical straight line. At G both sets of rays are divergent, and the figure is an oval with the long axis perpendicular.

There are various kinds of astigmatism, according

to the position of the two principal foci with reference to the retina.

1. *Simple Hypermetropic Astigmatism.* When the focus (V, Fig. 26) of the vertical rays is situated on the retina

FIG. 26.

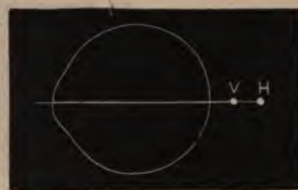


FIG. 27.

(emmetropia in that meridian), while that (H) of the horizontal rays lies behind the retina (hypermetropia in that meridian).

2. *Compound Hypermetropic Astigmatism.* When the foci of both sets of rays is behind the retina, that (H,

FIG. 28.

FIG. 29.

Fig. 27) of the horizontal rays further back than that (V) of the vertical rays.

3. *Simple Myopic Astigmatism.* When the focus (H, Fig. 28) of the horizontal rays is situated on the retina (emmetropia in that meridian), while the focus (V) of the vertical rays is situated in front of the retina.

4. *Compound Myopic Astigmatism.* When the foci of

both sets of rays are situated in front of the retina, but further forward in the case (V, Fig. 29) of the vertical rays.

5. *Mixed Astigmatism.* When the focus (H, Fig. 30) of the horizontal rays falls behind the retina (hypermetropia

FIG. 30.

in that meridian), and the focus (V) of the perpendicular rays in front of the retina (myopia in that meridian).

Symptoms of Astigmatism. We may conclude that an individual is astigmatic if he sees horizontal (or vertical) lines, such as the horizontal portions of Roman capitals or the horizontal lines in music distinctly, while the vertical (or horizontal) lines seem indistinct. We have such a complaint, for example, when the retina is situated at the focus of the parallel rays passing through the vertical meridian of the cornea.

The reason of this is, that a line (*a* and *b*, Fig. 31) may be regarded as a number of points, each giving out divergent rays, some of which rays falling into the eye pass through the horizontal meridian of the cornea, and others pass through the vertical meridian. In the above supposed case the eye will see the horizontal

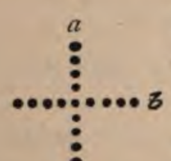


FIG. 31.

line (*b*, Fig. 31) distinctly, because the rays which diverge from each point of the latter in a vertical plane, *i.e.*, at

right angles to the direction of the line, are brought to a focus on the retina; while those rays diverging in a horizontal plane, although not meeting on the retina, do not render the picture of the line indistinct, because the diffusion images resulting from them exist in the horizontal direction, and consequently cover or overlap each other on the horizontal line, and therefore are not seen. At the ends of the line only (*b*, Fig. 32) do the diffusion images cause a "fuzziness," or make the line seem longer than it is. In this case a vertical line (*a*, Figs 31 and 32) seems indistinct; because, the horizontal meridian being out of focus, the diffusion images existing in that direction are very apparent, as they do not overlap. On the other hand, in order to see a vertical stripe accurately, it is necessary only that the rays diverging in a horizontal plane should have their focus on the retina; and, therefore, if an individual can only see vertical lines distinctly at 6m. we know that his eye is emmetropic in the horizontal meridian (and probably myopic in the vertical meridian). We do not, however, hear this complaint as often as might be expected, because simple astigmatism is not so common as one or other of the compound forms.

FIG. 32.

Astigmatic people do not generally see very distinctly, either far or near.

Even in hypermetropic astigmatism the book is very often brought close to the eyes, in order, by increasing the size of the image, to make up for its indistinctness.

Astigmatic individuals frequently suffer much from headache, due to constant effort to see distinctly, and we cure the headache when we correct the astigmatism.

All these signs and symptoms appertain more to the rather high degrees of astigmatism. Slighter degrees may cause no annoyance beyond some indistinctness of vision; and, indeed, slight degrees of hypermetropic astigmatism often pass unnoticed until late in life, when the accommodation begins to fail.

We are often led to suspect and seek for astigmatism, when, in examining the refraction with spherical glasses, we are able to bring about some improvement of vision, but cannot obtain normal V with any glass, while there is no organic disease to account for the defect. Also if, in examining with spherical glasses, we find V benefited equally by several glasses of considerable difference in power, even perhaps by convex as well as by concave glasses.

The ophthalmoscope affords us an admirable means of diagnosing astigmatism. Just as the astigmatic eye cannot see horizontal and vertical lines equally well at the same moment, so is an observer unable to see both the vertical and horizontal vessels in the retina of the eye simultaneously, but must alter his accommodation to be able to see first the one set and then the other. The shape of the optic disc also gives a clue to the presence of astigmatism. If the disc be truly circular it will appear in the astigmatic eye to be oval. But if, as often happens, the optic disc be really oval, then in astigmatism the oval will seem to lie with its long axis in one direction when observed in the upright image, and in the opposite direction when seen in the inverted image.

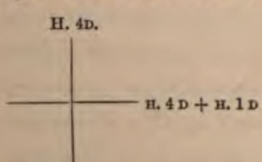
The Estimation of the Degree of Astigmatism, and its Correction. It is evident that, to correct astigmatism, the ordinary spherical lenses would be of little use, for they affect the refraction of the light passing through them equally in every direction. We employ, therefore, what are termed cylindrical lenses, which refract light in one direction only, viz. :—that corresponding to their curvatures and at right angles to their axes.

Simple Astigmatism. If a case come before us in which we suspect astigmatism, we place Snellen's Sunrise (*vide* diagram at end of book), or some such diagram, at 6 m. from the eye, and inquire of the patient whether there be any line which he sees much more distinctly than the others, and can trace further towards the central point. If that be so, we know that he is emmetropic in the meridian at right angles to that line; provided his accommodation be at rest.

In case the horizontal line below at each side be the distinct one, the eye is emmetropic in the vertical meridian, and probably hypermetropic in the horizontal meridian, because the latter is generally that of least curvature. Consequently, a convex cylindrical lens held with its curvature horizontally (axis vertical) before the eye, will correct the defect. The highest convex cylindrical glass which gives the patient the best possible distant vision, will be the correcting glass. This is a case of Simple Hypermetropic Astigmatism (As. H). If the lens required be + 2 D Cyl. it would be As. H. 2 D, and in prescribing for the optician we would write "+ 2 D Cyl. Ax. Vert."

If the central vertical line be the distinct one, then emmetropia exists in the horizontal meridian, and probably, therefore, myopia in the vertical meridian; and a concave cylindrical lens held before the eye with its curvature vertical (axis horizontal) will correct the defect. The lowest concave cylindrical lens, which gives the patient the best possible distant vision, will be the correcting lens. This is a case of Simple Myopic Astigmatism (As. M). If the lens be − 2·5 Cyl. it would be As. M. 2·5 D. And for the optician we would write, "− 2·5 D Cyl. Ax. horiz."

Compound Astigmatism. If no line be very distinctly seen, then we may commence our examination with Snellen's Distance Test Types, and test in the ordinary way with spherical lenses, until we find that one which gives the best distant vision. This we place in a spectacle frame before the eye, and proceed, as already explained, to ascertain the meridians of greatest and least curvature of the cornea. If the spherical lens be + 4 D, and with it the horizontal lines in the Sunrise diagram be the most distinct, then the vertical meridian is shown to be corrected, and the eye is probably still hypermetropic in the horizontal meridian, and requires a + cylindrical lens with its axis vertical, in addition to the spherical lens, to correct the entire defect. Suppose this cylindrical lens be found to be + 1 D Cyl. then the H in the horizontal meridian will be shown to be 5 D, and the astigmatism to be 1 D.

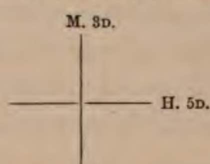


The latter noted down would be of little practical

value, and therefore we prefer to write in our note-books the factors of the Astigmatism, thus:— "H 4 D + As. H 1 D Ax. Vert.," or, as for the optician, "+ 4 D Sp. ⊃ + 1 D Cyl. Ax. Vert."* This is Compound Hypermetropic Astigmatism.

In an analogous way we examine for Compound Myopic Astigmatism, in which every meridian is myopic, but the vertical more so than the others.

Mixed Astigmatism. Lastly, we come across cases in which both concave and convex spherical lenses produce a certain amount of improvement, but neither give full vision. Placing then one or other before the eye in the spectacle frame, the examination is proceeded with by aid of Snellen's "Sunrise." We ascertain, for example, what is the lowest concave spherical lens which will bring out one horizontal ray distinctly, let this be − 3 D; we have then myopia of 3 D in the vertical meridian. Now, having



removed the − lens, we find what is the highest convex lens which will bring out one vertical line distinctly, let it be + 5 D; this indicates hypermetropia of that amount in the horizontal meridian. We may correct such a case in either of two ways:—(*a.*) By a Sph. − 3 D which will correct the vertical meridian, but will increase the hypermetropia in the horizontal meridian by 3 D, making it 8 D, which can then be corrected by combining a cylindrical lens of + 8 D, axis vertical, with the above spherical lens. (*b.*) By a spherical + 5 D which will correct the horizontal meridian, but will increase the myopia in the

* The sign ⊃ indicates "combined with."

vertical meridian to 8 D, necessitating the combination of a — Cyl. lens of that number, with the + 5 D Sph. For reading, writing, etc., the correction of the hypermetropic meridian alone would in such a case be probably sufficient.

As it is necessary, in order to test the degree, etc., of astigmatism accurately, that the accommodation be at rest, it is most important, before the examination for any of the hypermetropic forms, to instil atropine into the eye. But care must be taken in prescribing the glasses to make the necessary deduction for atropine. (*Vide* p. 52.)

The foregoing is a good clinical method, and can be employed by every one with the apparatus most commonly at hand. There are other diagrams which answer the purpose as well as Snellen's Sunrise. There are also other methods of determining astigmatism.

The estimation of the degree of astigmatism by aid of the ophthalmoscope is treated of in Chapter III.

Irregular Astigmatism.

In irregular astigmatism the refraction of the eye differs, not only in different meridians of the eye, but even in different parts of one and the same meridian. This is frequently due to irregularities on the surface of the cornea, the result of former ulcers, and also sometimes to irregular refracting power in different parts of the crystalline lens. It cannot be corrected.

Anisometropia

Means a difference in the refraction of the two eyes, one being myopic, hypermetropic, or astigmatic, while

the other is emmetropic, or ametropic in a way different from its fellow. So long as the difference in refraction is but slight, say 1 D or 1·5 D, it is generally possible to give the correcting glass to each eye. When the difference is considerable, it is often impossible to fully correct each eye, because binocular vision having never really existed, the patients are unable to tolerate the presence of a clear image on each retina. We must then be content with correction of the least ametropic eye, or of that one which has the best vision—or, we may partially correct the most ametropic and fully correct the least ametropic eye. Each such case must be dealt with as it permits.

ANOMALIES OF ACCOMMODATION.

Presbyopia.

This is a diminution in the amplitude of accommodation, which commences at an early age, and is due solely to natural changes taking place slowly in the eye. It might not, therefore, strictly speaking, be considered as an anomaly. The power of accommodation commences to grow feeble at the tenth year of age, and then the near point begins to recede from the eye. Donders it was who first discovered this fact, and ascertained the laws which govern the progressive decrease of accommodative power. He designed the accompanying diagram, (Fig. 33), which illustrates the decrease, and indicates the amplitude of accommodation at different ages.

The numbers along the upper horizontal line refer to the ages, those along the left hand perpendicular line to the dioptries. The curve *r r* shows the refraction

of the eye when in a state of rest. This is unchanged until the 55th year, when it begins to diminish; the emmetropic eye then becoming hypermetropic, the hypermetropic eye more hypermetropic, and the myopic eye less myopic. The curve *p p* shows the positive refracting power of the eye, and its gradual diminution as life

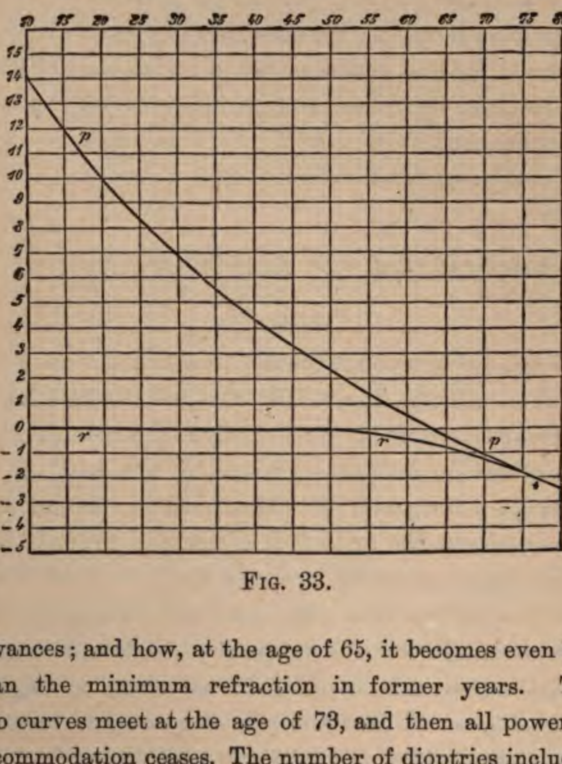


FIG. 33.

advances; and how, at the age of 65, it becomes even less than the minimum refraction in former years. The two curves meet at the age of 73, and then all power of accommodation ceases. The number of dioptries included between the two curves on the vertical line corresponding to any given age, represent the amplitude of accommodation at that age. The amplitude of accommodation is

the same at the same age in all forms of ametropia, as well as in emmetropia.

The cause of presbyopia lies chiefly in a progressive change in the crystalline lens, which becomes harder, and therefore less easily altered in its curvature. In more advanced life, diminished energy of the ciliary muscle becomes a factor in the production of presbyopia.

The near point gradually receding from the eye, it finally reaches a distance beyond that at which the person usually reads, writes, sews, &c. Employments of this kind then become difficult, because the retinal images are too small, owing to the distance at which the work must be held from the eye, and in order to make up for this smallness of the images, the individual seeks to improve their brilliancy by procuring stronger light.

Presbyopia is usually said to be present, when the near point lies at more then 22 cm. from the eye, and we correct it by giving such a convex glass for reading, &c., as will bring the near point back to 22 cm. Now, in order to see at that distance, a positive refracting power (p) of ($\frac{100}{22} =$) 4·5 D is necessary; and if the eye has not so much positive refraction, a convex glass must be given to it of such power as will bring p up to 4·5 D; and this lens is the measure of the presbyopia. At the age of 40 (*vide* Donder's Diagram, Fig. 33) the eye possesses a positive refraction of just 4·5 D; and, therefore, from this age presbyopia (πρεσβυς ωψ) is said to commence in emmetropic eyes. The presbyopia, then, is equal to the difference between the positive refracting power possessed by the eye and 4·5 D, and the number thus found is the correcting glass for the presbyopia.

The following table indicates the presbyopia of the emmetropic eye.

Age.	*p.* required.	*p.* existing.	Presbyopia.
40...	4·5	4·5	0
45...	4·5	3·5	1·0
50...	4·5	2·5	2·0
55...	4·5	1·5	3·0
60...	4·5	0·5	4·0
65...	4·5	0·25	4·75
70...	4·5	– 1·0	5·5
75...	4·5	– 1·75	6·25
80...	4·5	– 2·5	7·0

It is hardly necessary to point out, that presbyopia comes on at a much earlier age in hypermetropes than in emmetropes; while in myopes its advent is postponed; or, in the higher degrees of myopia, it may not come on at all. The hypermetrope of 3 D would be presbyopic at the age of 27; because, in order to arrive at the 4·5 D of positive refraction required, he must have an amplitude of accommodation of (3 D + 4·5 D) 7·5 D, and this he has only up to that age (*vide* Fig. 33).

The myope of 4·5 D can get along until something over 60 years of age without any glass for reading (*vide* Table). At 65, if he were emmetropic, he would have a presbyopia of 4·75; consequently, he will now require a + glass of (4·75 – 4·5) 0·25 D.

Paralysis of Accommodation.

This is usually combined with mydriasis. Its presence can only be ascertained by examination of the function, and it gives inconvenience to the patient according to the state of his refraction. If he be emmetropic, his distant

vision continues good, while his vision for near work is much impeded. If he be hypermetropic, as he requires his accommodation for distant objects, vision for distance is interfered with, and still more so vision for near objects. If he be myopic, vision is less affected than in either of the other forms of refraction; indeed, if he be very near-sighted he may suffer little or no inconvenience, being able to see near objects at his far point.

Micropsia is a common symptom in cases of partial paralysis of accommodation; and is due to the fact, that the great effort of the defective accommodation gives the sensation of the object being much nearer to the eye than it really is.

Causes. The most common cause of paralysis of accommodation is the action of atropine, but it is also the result of, or is attendant upon various diseases. It is one of the symptoms of paralysis of the third nerve; it may be due to exposure to cold; or it may depend upon syphilis, syphilitic periostitis at the sphenoidal fissure, syphilitic gumma, or syphilitic inflammation of the nerve itself.

In cases of double paralysis of accommodation a central cause must often be looked for. Paralysis of accommodation and mydriasis are sometimes forerunners by many years of serious mental derangement.

Diphtheria is a frequent cause of double paralysis of accommodation and mydriasis, and here the prognosis is always favourable.

Treatment. This depends chiefly upon the cause. In all cases, except those of central origin, solution of eserine should be instilled into the eye. Suitable convex glasses may be given for near work, pending the cure.

"Tone" of the Ciliary Muscle.

In every eye, even where there is no spasm of accommodation, a certain portion of the accommodation can only be relaxed by atropine. This is due to "tone" of the ciliary muscle. If in hypermetropia this be not taken into account, and if the lens found to correct the H. under atropine be prescribed, when the effect of the atropine wears off and the muscle recovers, the glass will not suit; because the restored "tone," in addition to the lens, will bring the rays to a focus in front of the retina. Therefore, in cases of hypermetropia, 1 D in adults, and 1·5 D or 2·0 D in children must be deducted from the lens found under atropine. In myopia the lens found under atropine will not be strong enough when the eye recovers from the drug, because the restored tone of the muscle goes to increase the myopia, and for this increase a concave lens of 0·5 D must be added to the lens found under atropine.

Spasm or Cramp of Accommodation has been treated of under the head of Hypermetropia (p. 25).

CHAPTER III.

THE OPHTHALMOSCOPE.

ALTHOUGH the dioptric media of an eye be perfectly clear and normal, yet no detail of its fundus can be discerned by the unaided eye of an observer who looks through the pupil, the latter being for him merely a dark opening. The reason of this is, that these dioptric media are composed of a system of convex lenses. To explain:—Sup-

FIG. 34.

pose the inside of a small box (*vide* Fig. 34) to be blackened, and on its floor some printed letters fastened, and that a hole be cut in the lid, which is then replaced: it will be found, that, by aid of a lighted candle and with a little experimentation, the letters may be read through the aperture. The rays passing from the light L into the box through the aperture illuminate the opposite surface, and

from this surface the rays, *a*, *b*, and others, pass out again through the opening, and some of them fall into the observer's eye at *E*. But if, in order to make this box represent an eye more accurately, we place a convex lens immediately within the aperture, the course of the rays is altered.

All the rays passing into the box (Fig. 35) from *L* are brought to a focus on its opposite side at *m* by the convex lens *n*; and, according to the optical law of conjugate foci, all the rays passing out from the box meet again at the source of light *L*, and hence none of them can be received

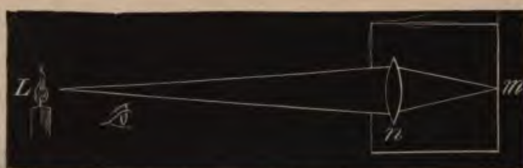


FIG. 35.

by the eye of the observer, nor can this eye be placed in any position where it could catch any of these rays; for if it be placed anywhere between the aperture and *L*, it would cut off the light passing from *L* into the box.

Helmholtz's Ophthalmoscope. If the eye of the observer could itself be made the source of light, the difficulty would be solved; and practically this is what Helmholtz accomplished with his ophthalmoscope in 1851. The instrument he first used was composed of a number of small plates of glass, *O* (Fig. 36), from which light from *L* was reflected into the eye *E*, and thus the fundus of the latter illuminated. From *m* rays pass back again by the

same course to the ophthalmoscope, some being reflected back to L, but some passing through the ophthalmoscope,

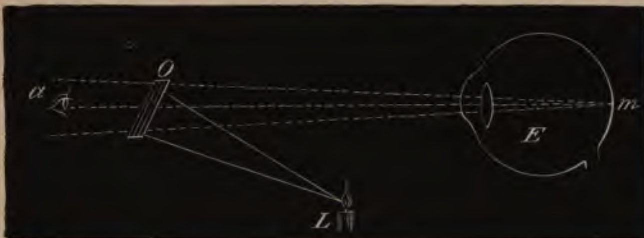


FIG. 36.

and falling into the observer's eye placed close behind the instrument at *a*, form in it an image of *m*.

Modern Ophthalmoscope.—For the original ophthalmoscope of Helmholtz a concave mirror of 20 cm. focal length with a central opening has been substituted. This mirror O (Fig. 37) throws convergent rays into the eye E; and

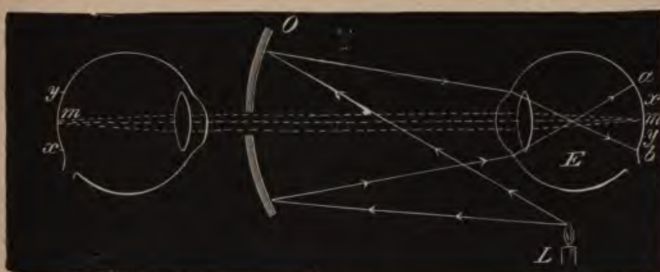


FIG. 37.

these, being made more convergent by the refracting media, cross in the vitreous humour and light up part (*a b*) of the fundus. From every point of this illuminated surface rays are reflected back again out of the eye. If

the latter be emmetropic, the rays on leaving it become parallel, and some of these parallel rays, passing through the aperture (c) of the ophthalmoscope, fall into the observer's eye, and, if it be emmetropic, are brought to a focus on its retina; the rays from m at m', those from x at x', and those from y at y', and thus an image of the part $x\ m\ y$ is formed on the observer's retina.

The foregoing method of examining with the ophthalmoscope is called the **Direct Method**, or, **The Examination of the Upright Image.** By it the various parts of the fundus are seen in their natural positions, but much enlarged (about 15 diameters in the emmetropic eye), and it is consequently very valuable for examining minute details.

It is necessary for this method that the surgeon should approach his eye as close as possible to the eye under examination, in order to receive as much of the light coming out of it as possible.

It is also necessary for this method that the accommodation both of the surgeon's and of the patient's eye be at rest, as otherwise the rays coming from the latter cannot form an image on the retina of the former, at least if both be emmetropic. The patient's accommodation will be relaxed by making him gaze at the black wall behind the surgeon's head, or his accommodation may be paralysed with atropine.

Voluntary relaxation of the accommodation on the part of the observer is often a matter of much difficulty to beginners. The ciliary muscle, not being a voluntary muscle, is not under our direct control, and can be influenced in a secondary way only through the conver-

gence of the optic axes; for this convergence is regulated by voluntary muscles, and is intimately associated with the accommodation. With parallel optic axes we have no accommodation; therefore, when we want to relax our accommodation, we produce parallelism of our optic axes. Still, when the beginner approaches his eye close up to that of his patient, the knowledge that he is so close to the object he wishes to see renders this parallelism and relaxation of accommodation very difficult.

It is not easy to teach another how to relax his accommodation, but the following hint may be of use. Take a printed page and hold it at the ordinary reading distance, so that the type may be clearly seen; then gaze vacantly at it, so that the type may become indistinct. The accommodation is now relaxed, and the act was accompanied by a peculiar sensation in the eyes. When examining in the erect image, cause this same sensation to take place; and it may be assisted, if, with the eye not in use, the black wall behind the patient's head be gazed at.

The Indirect Method, or **The Examination of the Inverted Image,** is employed in order to obtain a more general view of the fundus than the direct method admits of.

In addition to the ophthalmoscope a convex glass (*l*, Fig. 38) of about 14 D is here used. The latter is held about 10 cm. from the eye (E) under examination, while the observer throws the light through it into the eye. In passing through the lens the rays are made more convergent, and this convergence is increased by the refracting media, so that the rays cross in the vitreous humour, and light up a portion of the fundus oculi.

From any points *a* and *b* of this illuminated place pencils of rays pass out again from the eye, and, becoming parallel, pass through the lens, and are united by it at *a′ b′*; and thus a real inverted image is formed of the part *a b*, which image may be seen by the observer whose eye is placed behind O. The stronger the lens *l* the more convergent must rays from the examined eye be made; and, consequently, the closer must *a′* and *b′* be to each other, and the smaller and brighter must be the

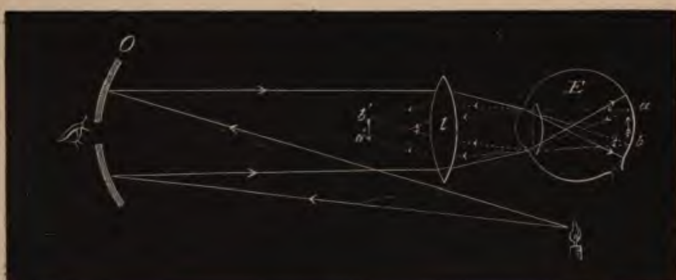


FIG. 38.

image formed. The weaker the lens *l*, the larger and less brilliant is the image.

In examining by the indirect method, the observer first places the upper edge of the ophthalmoscope to his right supra-orbital margin, and, taking care that he is looking through the central opening, he reflects the light of the lamp into the patient's eye at a distance of about 50cm. A red glare from the fundus will then be seen in the pupil. Keeping the pupil illuminated, the convex 14 D, held between the forefinger and thumb of the surgeon's left hand, is brought up in front of the patient's

eye, and kept there in the perpendicular position: the surgeon steadying this hand with the tip of the little finger on the patient's forehead. The convex glass is now removed just far enough from the patient's eye to cause the margin of the pupil to disappear out of the surgeon's field of vision. He then ceases to look into the eye, and fixes his gaze on the place where the inverted image of the fundus is formed, *i.e.*, at about the focus of the convex glass, or between this and the ophthalmoscope.

The diagram (Fig. 39) serves to illustrate the effect of inversion of the image.

FIG. 39.

The left eye is seen in the upright image in the left-hand picture, while the same eye is seen in the inverted image in the right-hand picture. In the diagram the two images are of the same size for the sake of convenience; although, of course, in reality the upright image is much larger than the inverted image. Moreover, it should not be supposed that nearly the whole fundus oculi, as here represented, can be taken in at one view with the ophthalmoscope. The portion visible with the ophthalmoscope at one moment, even in the inverted image, is small; so that it is necessary to examine the different regions in

detail, in order to become acquainted with their condition.

The reflex from the surface of the cornea gives a good deal of annoyance to every beginner. It cannot be done away with; but, as it moves in the opposite direction to a motion of the object lens, it is possible to see past it. The reflection from the convex object lens may be removed from the line of sight by a slight rotation of the lens on its axis.

To examine *the Optic Nerve*, the surgeon sits in front of the patient, and directs him to turn his eye somewhat to the opposite side, and slightly upwards; as the papilla is situated about 15° to the inner side of the posterior pole of the eye, and about 3° above it. For instance, if the left eye be examined, the patient is to direct his gaze, without turning his head, to the right and a little upwards, say towards the surgeon's right ear. It is well always to seek out the optic papilla in the first instance, not only because it is so important a part of the fundus oculi, but because, examining from it towards the periphery, we are the better able to determine the locality of any pathological alteration.

Should the patient not direct his gaze in such a way as to enable the surgeon to see the optic papilla, or other desired region, it may be brought into view either by a motion of the surgeon's head in the opposite direction. or by a motion of the convex lens in the same direction, or by a combination of both these manœuvres.

The Macula Lutea should then be examined. It may be seen by directing the patient to look straight at the hole of the ophthalmoscopic mirror, for it will then correspond

with the macula lutea of the observer's eye. It is more readily seen in the inverted than in the upright image; but its examination is often very difficult, owing to contraction of the pupil produced by the strong light falling on so sensitive a portion of the retina, and by the reflections from the surfaces of the cornea and crystalline lens, which fill the area of this contracted pupil. It is, therefore, a better plan to direct the patient to look somewhat to the side of the eye under examination, *e.g.*, to the right side of the observer's forehead, if the right eye be under examination, and then by motions of the convex lens to bring the macula lutea into view.

After this *The Periphery of the Fundus* in every direction is to be examined, by making the patient look upwards, downwards, to the right, to the left, etc.

ESTIMATION OF THE REFRACTION BY AID OF THE OPHTHALMOSCOPE.

From what has been said with reference to the Direct Method of ophthalmoscopic examination, it will have become evident, that it affords a means for determining the refraction of the eye. For this purpose the surgeon first corrects any ametropia he may himself possess.

At a little distance from the observed eye into which light from the ophthalmoscopic mirror is thrown, if it be either myopic or hypermetropic the surgeon will be able to see some of the details of the fundus, but if it be emmetropic he will not. In myopia the rays coming out of the eye form an inverted image at the far point of the eye in the air, and this image can be seen by the observer

who accommodates his eye for that point. In hypermetropia the rays coming out divergent from the eye pass into the observer's eye, and these form an upright image of the part of the patient's fundus oculi from which they come. But in emmetropia, as the rays come out parallel, those from any two points (*m*, *n*, Fig. 40) at a short distance from each other in the fundus, on emerging from the eye diverge quickly from each other, and the observer a little way off (at A) receives none of them into his eye,

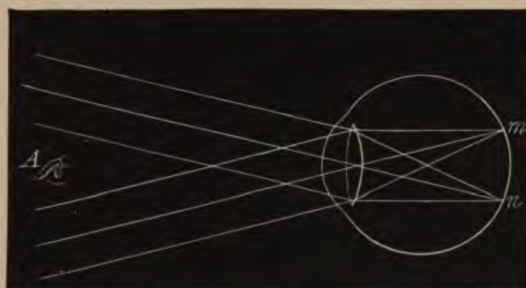


FIG. 40.

or obtains only an indistinct image or red glare. If he go very close to the eye he can see details.

If, on the observer moving his head from side to side, the vessels, etc., of the observed fundus move with him, the case is one of hypermetropia, because the image is an erect one. If the vessels, etc., move in the opposite direction to that of the observer's head, the observed eye is myopic, because there the image is inverted.

For the quantitative determination of ametropia a refraction ophthalmoscope (Loring's, Landolt's, Knapp's, Couper's, Fox', Nettleship's, Lang's, etc.) is required.

This instrument provides a number of convex and concave lenses, capable of being brought into position behind the sight-hole in rapid succession by a simple mechanism.

It is necessary, in the first instance, that the surgeon be aware of the nature of his own refraction.

If the Surgeon be Emmetropic he can see the fundus oculi of an emmetrope in the upright image without any lens, provided he go close enough; as the parallel rays coming from the examined eye will be focussed on his retina, because his eye is adapted for parallel rays.

In order to see the fundus oculi of a hypermetrope, he must place such a convex lens behind his ophthalmoscope, as will render the divergent rays coming from the patient's eye parallel, before they pass into his eye. This lens is the measure of the patient's hypermetropia, because it shows how many dioptries the eye wants of being emmetropic, or in order that the rays coming from it may be made parallel. The lens which makes the divergent rays coming from the patient's retina parallel, would also give to parallel rays passing into the eye such convergence that they would meet on the retina, *i.e.*, it would correct the hypermetropia.

To see the fundus oculi of a myope, the emmetropic surgeon must place a concave glass behind his ophthalmoscope, in order that the convergent rays coming from the observed eye may be made parallel, before they pass into his eye; and the lowest concave lens which enables him to see the fundus oculi is the measure of the myopia, as showing by how many dioptries it is in excess of emmetropia.

If the surgeon be ametropic, he may either correct his

ametropia by wearing the suitable lens, and then proceed as though he were emmetropic; or else, and which is perhaps the better plan, he may add or subtract the amount of his ametropia from that of his patients. For example:—

The Hypermetropic Surgeon of, say 3 D, requires a + lens of 3 D in order to see an emmetropic fundus oculi, this lens going altogether to correct his own defect. If, in order to examine the fundus of another eye, he require a + lens of 6 D, the examined eye must be hypermetropic 3 D, the other 3 D going to correct the surgeon's H. If he be able to see the fundus oculi under observation without any lens, it shows that that eye has an excess of refraction corresponding to the want of refraction in his own eye, that is to say, it is myopic 3 D. If he require a concave 2 D, his want of refraction is not enough by that number of dioptries, and he has to do with an eye which is myopic 5 D (3 D + 2 D).

If the Surgeon be Myopic, say 2 D, he requires a — 2 D to see the fundus of an emmetropic eye, this lens going wholly to correct his own ametropia. If he see the fundus with a — 7 D, the examined eye has M 5 D, for 2 D has been used in correcting the surgeon's M. If he be able to see a fundus without any lens, the patient has H 2 D, the want of refraction in the latter's eye compensating exactly for the excess of refraction in the surgeon's eye. If he find it necessary to use a + lens of 7 D it will indicate that his excess of refraction is not able to make up for the defect of refraction in his patient's eye, and that the latter has H = 9 D (2 D + 7 D).

The Existence and Degree of Astigmatism may be Deter-

mined with the Ophthalmoscope. We know that astigmatism is present, if, in the upright image, we see the upper and lower margins of the disc and the horizontal vessels well defined, while the lateral margins and the vertical vessels are blurred, or *vice versâ*. Again, we know that astigmatism is present, if, in comparing the shape of the optic disc in the upright and inverted images, we find it to be an oval with its long axis perpendicular in the former, and with its long axis horizontal in the latter, showing that the refracting media are more powerful in the vertical than in the horizontal meridian.

We may ascertain the kind and degree of astigmatism as follows:—If, in the upright image, we can see the retinal vessels in one meridian distinctly, while in order to see those in the opposite meridian a concave or convex lens behind the ophthalmoscope is required, we know that the case is one of simple myopic or hypermetropic astigmatism; the emmetropic meridian being that at right angles to the vessels seen without any lens, and the number of the lens indicating the amount of ametropia in the other meridian.

If, in the two principal meridians, two concave lenses, or two convex lenses of different strength be required, we have to deal with a case of compound astigmatism, myopic or hypermetropic; the greatest error of refraction being in the meridian at right angles to that, the vessels of which are made distinct by the strongest lens.

If a concave lens be required to bring into distinct view the vessels in one meridian, while a convex lens is required for the opposite meridian, the case is one of mixed astigmatism. Myopia exists in the meridian at

right angles to that in which the vessels are brought into view by the concave lens, and hypermetropia exists in the opposite meridian.

I would again impress upon the reader the absolute necessity of thoroughly relaxing his accommodation in all examinations in the upright image. Paralysis of the patient's accommodation with atropine is necessary in most cases, where accuracy in the determination of the refraction with the ophthalmoscope is required, and can hardly be done without in cases of hypermetropia and hypermetropic astigmatism, owing to the cramp of accommodation which is almost always present.

By Means of the Inverted Image the kind, and approximatively the amount, of ametropia may be ascertained. It is unnecessary to enter here into details concerning this imperfect method, and I shall merely state in general, that, if the case be emmetropic, when the object-glass is held close to the eye and gradually withdrawn from it, the image continues of the same size. In hypermetropia it diminishes in proportion to the amount of the defect. In myopia it increases in size in proportion to the amount of the defect.

Retinoscopy.

Another and very useful method for determining the refraction by the ophthalmoscope is termed Retinoscopy, Keratoscopy, or Pupilloscopy. The play of light and shade on the fundus of the eye is that upon which this method depends. Either a concave or a plane ophthalmoscopic mirror may be employed.

If the rays from a light (L, Fig. 41) be reflected from the concave mirror (*m*) of an ophthalmoscope, they cross at a certain point (A), and form there an inverted image of the flame, and then diverge again. If these diverging rays be made to pass through a convex lens (B) placed at such a distance in front of a screen (E) that the rays meet at a focus on the latter, a very small and brilliant upright image (O) of the flame

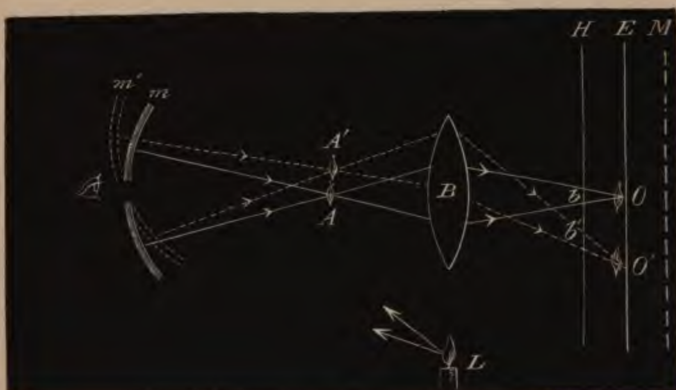


FIG. 41.

is there formed, surrounded by a deep shadow. If the screen be moved slightly towards the lens (to H), so that the focus of the rays would lie behind it, or if it be removed slightly away from the lens (to M) so that the focus come to lie in front of it, the brilliancy of the image on the screen and the intensity of the surrounding shadow are reduced. Because, in each instance a circle of diffusion, and not an accurate image, is formed on the screen, and the further the focus of the pencil of rays is

situated from the screen in either direction, the weaker does the image become and the more ill-defined the shadow.

If the mirror be rotated in various directions, the illuminated part and the shadow are seen to move in the opposite direction on the screen. For example, if the position *m′* be given to the mirror, the path of the rays reflected from it are shown by the dotted lines, and the image of O is moved to O′. This will also be the case if the screen be at H or at M. These three positions of the screen may be supposed to represent emmetropia (E), hypermetropia (H), and myopia (M). Figure 41 more particularly illustrates the motion of the light and shade in E and H only, while Fig. 42 demonstrates that in myopia.

In the eye, in like manner, the area of light and shade in the pupil moves against the motion of the mirror; but in one condition of refraction, myopia, it *seems* to move with the motion of the mirror.

In emmetropia and in hypermetropia the rays coming out of the observed eye are parallel and divergent, respectively; and, consequently, an upright image being formed by them in the observer's eye, the true motion given by the mirror is perceived.

In myopia, at least in all cases of more than 1 D, the observer does not see an upright image of the flame on the fundus of the observed eye, but a real inverted aerial image formed between his mirror and the observed eye. The reason of this is, that the rays coming out of the patient's eye are convergent, and meet at a focus which is the far point of the eye, and form there an inverted

image of the object from which they come, and which, in this instance, is an upright image of the flame (the illuminated area). When, therefore, the upright image on the fundus moves against the mirror, the inverted image (which is what the observer sees) moves in the opposite direction, *i.e.*, with the mirror. For example, if in Fig. 42 we suppose a to be the position of the image on the fundus of a myopic eye, and a^2 the position of

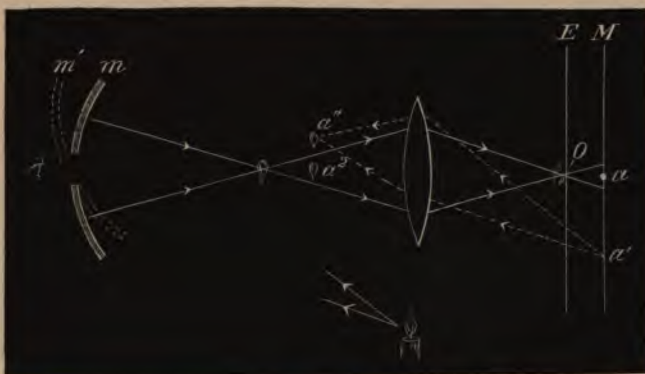


FIG. 42.

its real inverted aerial image; a motion of the mirror to m' (the rays from m' are omitted to avoid confusion in the diagram) throws the image of a to a', as already explained, but the inverted aerial image of a' is formed at a''; *i.e.*, it seems to have moved with the mirror.

In myopia alone, then, does the image move with the mirror, while in emmetropia and hypermetropia it moves against the mirror. In low myopia (1 D and less), as will just now be seen, the image also moves against the mirror.

From what has been said, it is evident, that the higher the ametropia (the further from the screen, in Fig. 41, the focus of the rays) the larger and feebler the illumination becomes (the greater the circles of diffusion), and the more crescentic the margin of the shadow, because it is the margin of a circle of diffusion.

Again, the extent of the motion of the image and its rate is in inverse proportion to the degree of the ametropia. Thus, if Fig. 43 represent a myopic eye, whose far point is situated at a^2, a motion of the mirror to m' may be supposed to throw the illuminated part to a' and

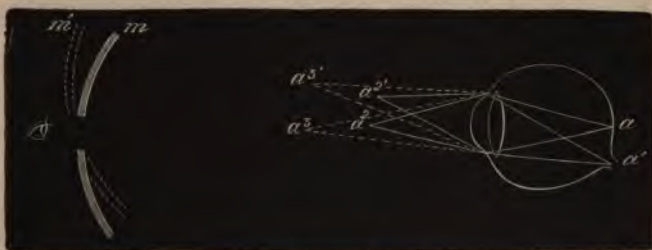


FIG. 43.

then a^2 will move to $a^{2\prime}$. But, if the myopia be of less degree, so that the far point is at a^3, the same motion of the mirror will throw a^3 to $a^{3\prime}$, and the distance between these two latter points is evidently much greater than that between a^2 and $a^{2\prime}$. In a hypermetropic eye (Fig. 44) the image may be supposed to be formed at a, and a motion of the mirror to m' will throw it to a', while in a higher degree of hypermetropia it would be formed at b, and the same motion of the mirror would throw it to b'. The distance between b and b' is much greater than that between a and a'.

In practising retinoscopy with the concave mirror the surgeon sits 1·20 m. in front of the patient. The eye to be examined is shaded from the direct rays of the lamp, if the latter be placed beside the patient; but a better plan is to have the light above his head. The focus of the mirror should be 22cm., and any error of refraction of the surgeon is to be corrected. The light is then thrown into the eye at an angle of about 15° with its axis of vision, so that, if the pupil be not under the influence of atropine, the macula lutea may be avoided. In children, and when

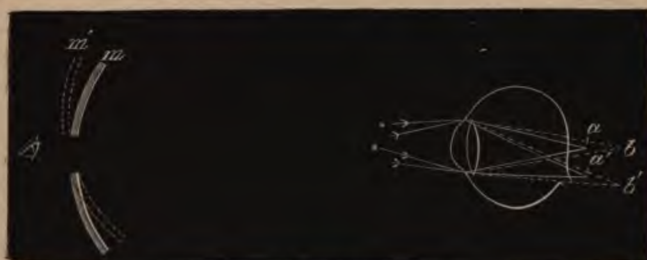


FIG. 44.

the pupil is very small, it is advisable to dilate it with atropine, and then the region of the macula lutea may be utilized. When now the ophthalmoscope is rotated in different directions, motions of the light and shade on the fundus oculi are seen in the pupillary area. The surgeon directs his attention to the *edge of the shadow* rather than to the illuminated part, for its motion is more easily appreciated. If the edge of the shadow moves *with* the motion of the mirror, *myopia* is present; if it moves *against* the mirror, emmetropia, hypermetropia, or myopia of 1 D or less, is present.

The reason why the motion is against the mirror in cases of M. 1 D and less is that, the surgeon being seated only 1·20 m. from the eye he is examining, if that eye have a myopia of 1 D, its far point is so close to his eye that he cannot clearly observe the image there formed; and, if the myopia be of even slighter degree, the image will be formed behind the surgeon's head, and he gets a shadow moving against the motion of his mirror, because the image he then sees is the upright one on the patient's fundus oculi, and not the inverted aerial image.

We proceed as follows:—A trial spectacle frame is put on the patient's face. If the shadow moves with the mirror, we know at once the eye is myopic. To find the degree of myopia, the surgeon puts a low-concave glass, say — 1 D, into the frame, and if the shadow still moves with the mirror, he puts in a higher number, say — 1·5 D, and so on, until he comes to a glass which makes the image move against the mirror. If this be — 3 D, the myopia is 3 D. It might be supposed, as the shadow now moves against the mirror, that this glass over-corrects the myopia, but this is not so; because, as already explained, when the myopia is very low, the image is formed close to the surgeon's eye, or behind his head, and he consequently gets a shadow moving against the mirror, although emmetropia is not present. Consequently, — 0·5 D or — 1D, has to be added on to the lens which gives the effect of no distinct shadow; or rather, by the above plan, it is not deducted from the lowest lens which makes the shadow move against the mirror.

If the shadow moves against the mirror, we have to

determine whether the eye be emmetropic, hypermetropic, or slightly myopic. Should the illumination be bright and the shadow well defined, the eye is emmetropic, or not far removed from it, and if the shadow be ill defined and crescentic we may feel sure the eye is highly hypermetropic. We first put on + 1 D, and if the motion be still against the mirror the case is one of hypermetropia, and higher numbers are at once proceeded with, until that one is reached which causes the shadow to move with the mirror. The measure of the hypermetropia is 1 D less than the glass so found, for it has evidently over-corrected the defect.

If, however, on putting on + 1 D we find the shadow to move with the mirror, we change it for + 0·5 D, and if still the motion be with the mirror, the eye is, beyond doubt, slightly myopic − 0·5 D or so. But if with + 1 D the shadow moves with the mirror, while with + 0·5 it continues to move against it, the eye is emmetropic.

It may be found, that in two opposite meridians there is a difference in the motion of the shadow, and this leads us to diagnose the presence of astigmatism. When the difference is one merely of rapidity of motion, or of intensity of illumination and shadow, we know that we have to deal with either simple or compound astigmatism. But if in the two meridians there is a difference in the direction of the motion, then it is a case of mixed astigmatism. The best method for ascertaining the degree of astigmatism and its correcting-glass is to correct each of the principal meridians separately with spherical lenses. In compound astigmatism the difference between the two

lenses found indicates the degree of astigmatism, and also the cylindrical lens, which, combined with the correcting spherical lens for the least ametropic meridian, is required to neutralize the defect. In mixed astigmatism the addition of the two numbers gives the cylindrical lens, while one or other of them, usually the + D, is used as the spherical lens.

The plane mirror can be employed with as great accuracy and satisfaction as the concave mirror in retinoscopy, indeed many ophthalmologists prefer it.* Here the source of illumination of the observed eye being, not a real inverted image of the light, as in the case of the concave mirror, but a virtual upright image formed behind the mirror, and as this image moves in the opposite direction to the motion of the mirror, the motion of its illumination on the fundus of the patient's eye must be *with* the mirror in all cases, and not against it, as in using the concave mirror. With the plane mirror therefore the shadow moves with the motion of the mirror in H and E and against it in M, just as do the vessels, &c., in the examination in the upright image. With the plane mirror it is possible to stand about 4 m. from the patient, and yet to throw sufficient light for the examination into his eye ; and, therefore, the trials with low + lenses to determine the question of E, H, or weak M become unnecessary, as at that distance the surgeon is beyond the far point of any except an eye with quite insignificant myopia.

* Mr. Story, *Ophthalmic Review*, August, 1883.

THE NORMAL FUNDUS OCULI AS SEEN WITH THE OPHTHALMOSCOPE.

Reference has been made to the enlargement of the image of the fundus oculi seen with the ophthalmoscope. The cause of this enlargement is, that the fundus is observed through a dioptric system, at, or close to the principal focus of which it is situated, and which consequently magnifies it to our view. The enlargement of the inverted image is not so great as that of the upright image, and it is smaller the shorter the focal length of the convex lens employed. The inverted image of a hypermetropic eye is larger than that of an emmetropic eye, and the latter larger than that of a myopic eye. It is possible to determine mathematically the degree of enlargement of the image.

The Optic Papilla.—This is the first object to be sought for by the observer. It presents the appearance of a pale pink disc, somewhat oval in shape, its long axis being vertical. Occasionally the long axis lies horizontally, and sometimes the papilla is circular. The papilla is generally surrounded by a white ring, more or less complete, called the sclerotic ring, and often outside this again by a more or less complete black line, the choroidal ring. The sclerotic ring is due to the choroidal margin not coming quite up to the papilla, and in this way leaving a narrow edging of the white sclerotic visible. The choroidal ring is the result of a hyper-development of pigment at the margin of the choroidal foramen. The complexion of the optic papilla results from its fine capillary vessels, combined with the whiteness of the lamina cribrosa, and the

bluish shade of the nerve fibres. It is frequently not equal all over, but is paler on the outer side, where the nerve fibres are often fewer than on the inner side. The apparent colour of the papilla depends also upon the complexion of the rest of the fundus. If the latter be highly pigmented the papilla appears pale in contrast; while, if there be but little pigment in the choroid, the papilla may appear very pink. The complexion of every normal papilla is not identical, and care must be taken not to make the diagnosis "Hyperæmia of the papilla," where merely a high physiological complexion is present.

A physiological excavation of the optic papilla is often met with. It is always on the temporal side of the papilla, and can be recognized from the parallax which may be produced, and from the paleness of this portion of the papilla. When the excavation is very deep, one may sometimes observe the lamina cribrosa in the form of grey spots (the nerve fibres), surrounded by white lines (the fibrous tissue of the lamina). A physiological differs ophthalmoscopically from a pathological excavation, by the fact that it never reaches the margin of the papilla all round. It is caused by the crowding over of the nerve fibres to the inner side of the papilla.

The Normal Retina is so translucent that it cannot be seen; or at most, about the region of the yellow spot of children and young persons, a shimmering reflection or shot-silk appearance is obtained from it, especially in the direct ophthalmoscopic method.

The Macula Lutea is generally seen as a bright oval ring with its long axis horizontal, this ring being probably a reflex from the surface of the retina. The inside

area of the ring is of a deeper red than the rest of the fundus, and at its very centre is an intensely red point, the fovea centralis.

The General Fundus Oculi surrounding the optic papilla and macula lutea varies a good deal in appearance, according to the amount of pigment contained in the choroid, and in the pigment epithelium layer of the retina. 1. If there be an abundant supply in each of these positions, the choroidal vessels are greatly hidden from view, and the effect is that of a very dark red fundus. 2. If there be but little pigment in the pigment epithelium layer, the larger choroidal vessels may be visible, and the fundus may appear to be divided up into dark islands surrounded by red lines. 3. If the individual be a blonde, there is little pigment either in the pigment epithelium layer or in the choroid, and the fundus is seen of a very bright red colour, the choroidal vessels in their fine ramifications being discernible. In albinos even the choroidal capillaries may be seen.

The Retinal Vessels. The arteries are recognized as thin bright red lines running a rather straight course, in the centre of each of which is a light-streak due to reflection from the tense coat of the vessel. This light-streak divides the vessel into two red lines. The veins are darker, wider, and more tortuous in their course than the arteries, and, their coats not being so tense, there is no light-streak.

On reaching the level of the nerve fibre layer of the retina, the central artery and vein divide into a principal upper and lower branch. This first branching often takes place earlier in the vein than in the artery, and the

former may even branch before appearing on the papilla, as in Fig. 45. The second branching may take place in the nerve itself; and, when this occurs, it will appear as though four arteries and four veins sprang from the optic

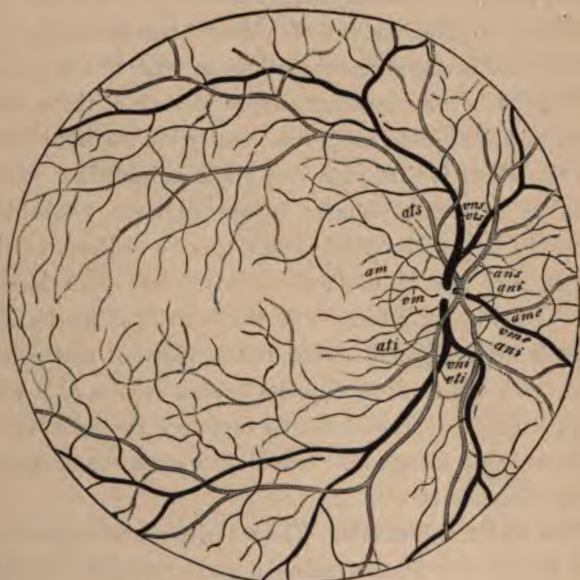


FIG. 45. (*Graefe and Sæmisch.*)

A.N.S. Art nas. sup.; A.N.I. Art. nas. inf.; A.T.S. A.T.I. A. temp. sup. and inf.; V.N.S. V.N.I. Ven. nas. sup. and inf.; V.T.S. V.T.I. Ven. temp. sup. and inf.; A.M.E. V.M.E. Art. and ven. median; AM. VM. Art. and ven. macularis.

papilla; but more usually this branching occurs on the papilla, as in Fig. 45. The vessels produced by this second branching pass respectively towards the median and temporal side of the retina, and are termed by Magnus the Art. and Ven. nasalis and temporalis sup.

and inf. (*vide* Fig. 45). The temporal branches run in a radial direction towards the anterior part of the retina. A small horizontal branch, the Art. and Ven. Mediana of Magnus, from the first principal branches, is found passing towards the nasal side of the retina. The temporal branches do not run in a horizontal direction, but make a detour round the macula lutea, sending fine branches towards the latter. Two or three minute vessels from principal branches run directly from the papilla towards the macula lutea; and around the macula lutea a circle of very fine capillary vessels is formed, which cannot be distinguished with the ophthalmoscope; but no vessels run to or cross over the fovea centralis itself. The retinal arteries do not anastomose, nor do the larger retinal veins. The small retinal veins have some slight anastomoses near the ora serrata.

No pulsation of the arteries is observable in the normal eye. In the larger veins near, or on the optic papilla, or, more usually, just at their point of exit, a pulsation may sometimes be seen. This venous pulsation is due to the following sequence of events:—Systole of the heart; diastole of and high tension in the retinal arteries; consequent increased pressure in the vitreous humour; communication of this to the outside of the walls of the retinal veins, impeding the flow of blood through them, especially in their larger trunks which offer little resistance, or at their exit from the eye where they offer the least resistance; and in this way the veins are emptied: the blood gradually coming on from the capillaries overcomes the resistance, and the veins are for a moment refilled. The phenomenon can be most readily observed, if the

normal tension of the globe be slightly increased by pressure of a finger.

A peculiar, but physiological appearance is produced by retention of their neurilemma in some of the nerve fibres after they have passed into the retina. Instead of being semi-transparent their fibres then reflect the light strongly, giving the effect of an intensely white spot commencing at the papilla, extending more or less into the surrounding retina, and terminating in a brush-like extremity.

FOCAL, OR OBLIQUE ILLUMINATION

is employed for the examination of the cornea, iris, and lens. With a high + lens (16 to 18 D) the light of the gas flame is concentrated on the part to be examined with an oblique, not a perpendicular incidence of the concentrated rays. Small foreign bodies in the iris, cornea, or lens, or opacities in either of the latter can be thus detected. Extremely delicate opacities in the cornea are not seen best with the strongest illumination which can in this way be produced, but rather by the half light which is obtainable at the edge of the cone of light passing from the lens. In examining the centre of the crystalline lens, the incidence of the light must necessarily be more perpendicular.

CHAPTER IV.

DISEASES OF THE CONJUNCTIVA.

Hyperæmia of the Conjunctiva. In this condition the bloodvessels of the palpebral conjunctiva especially are engaged. Slight chemosis sometimes appears, small vesicles may form, and there may be also some swelling of the papillæ, and development of lymph follicles. There is not any abnormal discharge from the conjunctiva, and herein lies the chief point of difference between this affection and simple conjunctivitis.

Causes. Foreign bodies. Foul air, or air loaded with tobacco smoke. Accommodative asthenopia. Stenosis lachrymalis, and other forms of lachrymal obstruction. The use of unsuitable spectacles, or the use of the eyes for near work without spectacles when the condition of the accommodation (*e.g.*, hypermetropia, presbyopia) requires them.

Symptoms. The eyes are irritable. There is tearing and photophobia, with hot burning sensations, and sensations as of a foreign body in the eye, and the eyelids feel heavy. All these symptoms are aggravated in artificial light.

Treatment. The cause to be removed. Iced compresses are to be applied for 15 to 20 minutes several times a day,

and one drop of the following is to be put into the eye once a day :—

Tinct. opii.
Aq. destill. aa. ℥ i.

The eyes should be protected from glare of light by dark glasses, while, at the same time, out-of-door exercise is to be insisted on; for there is no better remedy in this, and in some other conjunctival diseases, than the fresh open air.

Conjunctivitis (in general). In addition to hyperæmia there is here abnormal secretion. There are several forms of conjunctivitis, the discharge from each being more or less contagious. The secretion from any given form will not, however, always reproduce that form, but may give rise to another of greater or less severity. Infection may take place, either by the direct application of the secretion, or through the air, in which float particles of the infecting substance. This latter mode is especially liable to exist in an ill-ventilated room, where a number of people affected with conjunctival diseases are lodged with others who possess healthy eyes, *e.g.*, in crowded charity schools.

Catarrhal or **Simple Acute Conjunctivitis.** Hyperæmia is well marked, extending sometimes as far as the cornea, and concealing the Meibomian glands from view. Lymph follicles and enlarged papillæ are often present, but not necessarily so. There is a sticky serous secretion, which causes the eyelids to be fastened together on awaking in the morning, and sometimes produces ulceration of the intermarginal portion of the eyelids. The catarrh may become chronic, and then the papillæ are

more developed, while the blepharitis is liable to extend over to the cutis, causing eversion of the lower punctum lachrymale with resulting stillicidium. This latter condition gives rise to fresh conjunctival irritation, and thus a vicious circle is set going.

The Symptoms are those of a severe case of hyperæmia, with the addition of the annoyance consequent on the secretion. Photophobia is not generally severe unless there be some corneal complication.

Causes. Draughts of cold air. Contagion. Foul atmosphere. Foreign bodies. As a sequel of, or attendant on scarlatina, measles, and smallpox.

The Prognosis is good, unless there be reason to suspect that the mild form is but the commencement of a more severe inflammation. Small infiltrations, or ulcers sometimes form at the margin of the cornea, but are not of serious import.

Treatment. Cold or iced compresses in the first stage, with the use of a 4 per cent. solution of boracic acid as a lotion, used frequently. When the irritation and swelling have somewhat subsided, a solution of nitrate of silver, 10 grains to ℥i, should be applied by the surgeon to the palpebral conjunctiva with a camel's hair pencil, the lid being well everted, and this then should be thoroughly neutralized with salt water, the whole being finally washed off with plain water. The application should be repeated in twenty-four hours, by which time the slight loss of epithelium, result of the superficial slough, will have been repaired. Immediately after such an application, cold sponging or iced compresses are useful and grateful to the patient. If it be necessary to allow the patient to treat

himself, eye-drops, to be used once a day, should be prescribed, *e.g.*, Arg. Nitr. gr. ss. to Aq. dest. ℥i. or

Acid. Boracici, gr. x.
Zinci. Sulph. gr. iv.
Tinct. opii, ʒ ii.
Aq. destill. ad ℥ ii.
Solve.

A long continued use of even a weak solution of nitrate of silver as eye-drops discolours the conjunctiva, and should be guarded against.

A weak boracic acid ointment to be applied along the margins of the lids at bedtime is to be ordered. It prevents the unpleasant and injurious "gumminess" in the morning.

Follicular Conjunctivitis. This is catarrhal conjunctivitis, to which is added the presence in the conjunctiva of small round pinkish bodies the size of a pin's head, which disappear completely as the process passes off, leaving the mucous membrane as healthy as they found it.

These little bodies are situated chiefly in the fornix of the conjunctiva, and may be discovered by eversion of the lower lid, when they will be seen arranged in rows parallel to the margin of the lid. Whether they are easily discovered or not depends on their size and number, and on the amount of co-existing hyperæmia or chemosis of the conjunctiva. The structure of these bodies shows them to be lymph follicles.

Follicular conjunctivitis is a very tedious form, lasting often for months; and, according to Sæmisch, is more

apt to give rise to marginal ulceration of the cornea than the simple catarrhal form.

The disease has nothing whatever to do with granular ophthalmia, although some authors regard it as an early stage of the latter.

The Symptoms are much the same as those of catarrhal conjunctivitis. Frequently there is little or no injection of the bulbar conjunctiva, and the chief symptom is asthenopia—an inability to continue near work for any length of time—and much distress in artificial light. Boys and girls from five to fifteen years of age are those most liable to this affection.

Causes. These also are much the same as in simple catarrhal conjunctivitis. The long-continued use either of atropine or of eserine is liable to bring on the disease.

Treatment. The remedy I have found most useful in this troublesome affection is an ointment of sulphate of copper from gr. ss. to gr. ii in ʒi of vaseline. The weaker ointments should be used at first, and later on the stronger ones, if it is found that the eye can bear them. The size of half a pea of the ointment is inserted into the conjunctival sac with a camel's hair pencil once a day. Eye-drops of equal parts of tincture of opium and distilled water are of use in some cases; and the eye douche should be recommended. Abundance of fresh air, with change from a damp climate or neighbourhood to a dry one are of importance. If the use of a solution of atropine have induced the disease, it should be discontinued; and, if a mydriatic be still required, a solution of extract of belladonna (gr. viii ad ℥i) may be employed in its stead.

Spring Catarrh is the eye complication which accompanies that troublesome affection known as "Hay Fever." It is not, strictly speaking, a catarrhal affection, for it is usually unattended with secretion, and the prefix "Spring" is misleading, as it is seen also in summer and autumn. The hay harvest is the most common period for it, owing probably to certain minute particles which then float in the air.

The bulbar conjunctiva is chiefly affected. It becomes injected, slightly œdematous, and close around the cornea somewhat elevated, with greyish swellings. The margin of the cornea itself is apt to become invaded with minute infiltrations.

Some individuals are liable to be attacked at each hay harvest. The chief symptom is photophobia.

Treatment. Dark glasses for protection from the light, weak astringent collyria (sulphate of zinc, acetate of lead), with cold sponging, or the douche. Pagenstecher highly recommends massage twice daily in conjunction with strong precipitate ointment.

Granular Conjunctivitis, or **Granular Ophthalmia** (also called Egyptian Ophthalmia and Military Ophthalmia). In this disease, in addition to the usual appearances of simple conjunctivitis, there are developed greyish-red bodies about the size of the head of a pin, situated in and close to the fornix conjunctivæ, chiefly of the upper lid, but also disseminated over other parts of the membrane. These bodies are the "granules" or "granulations," and, in the acute form of the disease, they somewhat resemble the follicles of follicular conjunctivitis, but are paler, not so apt to occur in rows, and are more isolated.

Microscopically the granulations have no capsule, as have the follicles, but seem to grow from or in the stroma of the conjunctiva. In the acute form the granulations consist of lymph cells alone, but in the chronic form this is true of them only towards their surface, while at their bases they are formed chiefly of connective tissue. They are to be regarded as new growths in the conjunctiva.

The disease comes under our notice in two forms, the acute and the chronic. The latter may result from the former, but more commonly we find it as the primary condition, without any appreciable acute stage having gone before.

Causes. Both forms are contagious. Sattler has discovered the presence of micrococci in the secretion. The acute form is said to be often epidemic in places where the hygienic conditions are bad, although in this country I have never seen it as an epidemic, and sporadically not often. The chronic form is extremely common here, owing probably to the overcrowded and dirty condition of the dwellings of the lower orders, combined with the dampness of the climate. Amongst the better classes the disease is very uncommon. High, dry, mountainous countries are almost free from this disease. Some hold that the affection is dependent on constitutional disease, such as scrofula, tuberculosis, syphilis, etc.; but I cannot endorse this view. No doubt many of these patients are anæmic and out of health, but this is due to the moping habits they contract and the little open air exercise they take, in consequence of their semi-blindness.

Acute Granular Ophthalmia. As already stated, this is an affection rarely seen in this country. An attack

commences with swelling of the upper lid, great injection of the whole of the bulbar and palpebral conjunctiva, and swelling of the papillæ, with development of the characteristic "granulations." There may be but little discharge; but there is generally much lachrymation, with photophobia and great pain in the brow and eye. Superficial marginal ulcers of the cornea may form.

The inflammation and papillary swelling increase for a week or so to such a degree, that the granulations are hidden from view; and then, taking on a blennorrhœic form, the process gradually subsides, until in the course of two or three weeks longer it disappears, having brought about absorption of the granulations, and ultimately the mucous membrane is left in a healthy state.

If, however, in the blennorrhœic stage, the inflammation be excessive, the eye may run all the dangers of an attack of acute purulent conjunctivitis. Or if, on the other hand, the inflammation be very slight, it may not be sufficient to effect absorption of the granulations, and the process may run into the chronic form.

Treatment. It is desirable to abstain from active measures in the commencement of the affection, owing to the tendency to natural cure which is often present, and, in particular, astringents and caustics should be avoided. At the most an antiseptic lotion of boracic or salicylic acid, and cold applications for relief of the pain and heat, are admissible. Dark protection-glasses are agreeable, and, wearing them, the patient should be encouraged to take open air exercise. But, if it be evident that the inflammatory reaction is not active enough, poultices or warm

fomentations should be employed to promote it. Once the blennorrhœic stage has been reached, great care is required to control it; and if it threaten to exceed safe bounds, it must be restrained by means of suitable applications, such as acetate of lead, nitrate of silver, or sulphate of copper in solutions of medium strength; or, it may be necessary to use them in strong solutions; or even to employ the solid mitigated nitrate of silver.

Chronic Granular Ophthalmia. The first onset of this disease is often without inflammation, and is then unattended by any distressing symptoms, except that the eye may be more easily irritated by exposure to cold winds, foreign bodies, etc., or more easily wearied by reading and other near work. If such a case come under our notice, the conjunctiva will be found free from injection or swelling, but greyish-white semi-transparent granulations of the size of a rape seed and less will be seen disseminated over the conjunctival surface, and protruding from it. Gradually these granulations give rise to a more or less active vascular reaction, attended with swelling of the papillæ—in short, blennorrhœa. The patients then begin to be more inconvenienced, owing to the discharge which obscures their vision, and to sensations of weight in the lids and of foreign bodies, and this is generally the earliest stage at which we see the disease. The enlarged papillæ sometimes grow to a great size, completely hiding the granulations. In this stage the granulations may become absorbed, and the disease undergo cure, but more commonly it makes further progress. Fresh granulations appear, while the old ones increase in size, until they often become con-

fluent, leaving only here and there an island of vascular mucous membrane.

These chronic granulations consist of lymph cells

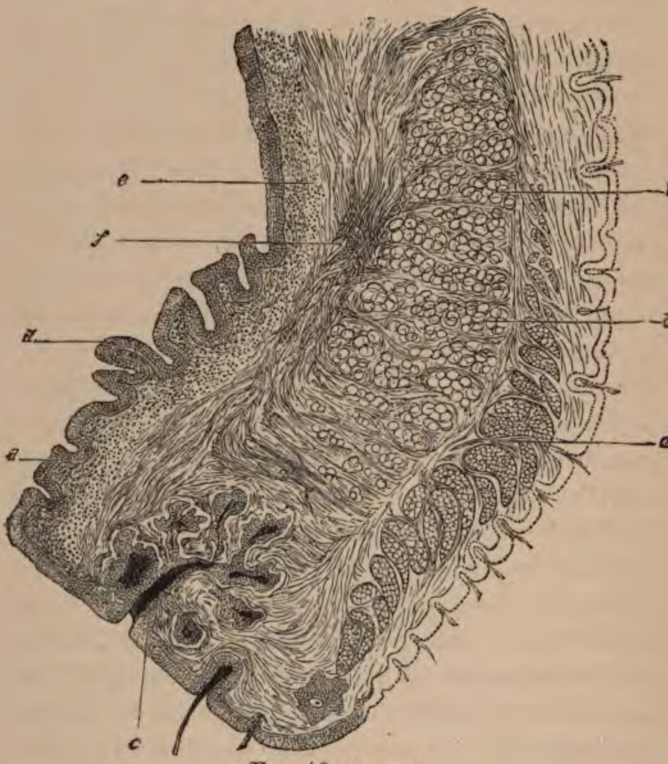


FIG. 46. (*Sæmisch.*)

a, Muscle; bb, Cartilage having undergone fatty degeneration; c, Atrophied Meibomian gland; dd, Hypertrophied papilla; e, Cicatricial tissue in the conjunctiva; f, Cartilage.

towards their surface, but towards their bases are formed chiefly of connective tissue. Gradually the cellular

elements are transformed into connective tissue, and in this way cicatricial degeneration of the conjunctiva is brought about at each spot where a granulation was seated.

As the disease advances, the submucous tissue becomes implicated in the connective tissue alterations, while the cartilage undergoes fatty degeneration and becomes hypertrophied. The granulations disappear, having reduced the conjunctiva to a cicatrix. Contraction of the diseased conjunctiva on the inner surface of the lid causes entropion and distortion of the bulbs of the eyelashes, giving rise to irregular growth of the latter with resulting trichiasis and distichiasis. These changes are represented in Fig. 46.

The great danger of granular ophthalmia lies in the complications which may attend it, or which follow in its wake. The former consist in pannus and ulcers of the cornea, and severe purulent conjunctivitis, while the latter are the distortions of the lids and eyelashes just referred to.

Pannus is a superficial vascularisation of the cornea with more or less diffuse opacity (Fig. 47), and often small infiltrations or ulcerations. It may come on at almost any stage of the conjunctival disease. It invariably commences in the upper portion of the cornea, extending generally over the upper half, and frequently remains confined to this region; but in many cases, at a later stage, it extends to the whole surface of the cornea, and this latter occurrence often takes place almost suddenly. The pannus vessels are prolongations of the conjunctival vessels, and run either immediately over or

under Bowman's membrane; and the opacity is due to development of connective tissue between Bowman's membrane and the corneal epithelium. The vascularisation and opacity may become so intense as to present quite a fleshy appearance, and to completely hide the corresponding part of the iris from view. Pannus is usually a painless affection, but is sometimes accompanied with photophobia and ciliary neuralgia. It gives rise to defective vision in proportion to the degree and extent of the opacity. Severe pannus is liable to induce iritis.

FIG. 47.

The connection between pannus and the condition of the lids is not easily explained. It is held by many that this corneal affection is due to mechanical irritation, caused by the rough conjunctiva, but I hardly think this view is correct, for severe pannus is often seen with a comparatively smooth conjunctiva, while with a truly rough conjunctiva the cornea is frequently perfectly clear.

At any stage prior to cicatrisation of the conjunctiva, an attack of purulent blennorrhœa is liable to come on. If not too severe, this may result in a cure by absorption of the granulations, and should not be checked. If, however,

the attack be very severe, the eye runs dangers similar to those of an ordinary attack of purulent conjunctivitis. These dangers are less, the more complete, and the more intense the pannus.

Prognosis. On the whole, if the disease come under treatment at an early period, it may be hoped that vision will be retained in a majority of cases, although a radical cure may be difficult or impossible. These cases require to be under constant or intermitting treatment for long periods, often for years.

Treatment. The aim of this is to bring about absorption of the granulations with the greatest possible despatch, in order to prevent the destruction of the mucous membrane to which they tend. No caustic application should be made with the object of directly destroying the granulations, for this can only be done at the expense of the mucous membrane around them. As already said, in cases of chronic granular ophthalmia in which a blennorrhœic attack comes on, when this passes off again the granulations are found to have become much fewer, or to have quite disappeared. Following the hint nature thus gives us, we should endeavour by our treatment to produce a certain papillary reaction. For chronic cases, with little swelling of the papillæ (blennorrhœa) and with little or no cicatrisation, the best application is the solid sulphate of copper lightly applied to the conjunctiva, especially at its fornix; but, when there is considerable papillary swelling, I prefer a 10-grain solution of nitrate of silver, properly neutralised after application with a solution of salt. An interval of 24 hours at least should be allowed to elapse between each application,

whether of sulphate of copper or nitrate of silver, and cold sponging for 15 minutes should be employed immediately after the application. A change of treatment will be occasionally required, even if the remedy first used answer well in the beginning, and one or other of the following can be adopted :—Liq. plumb. acetatis dil., never to be used except with everted lids, and washed off with plain water by the surgeon; and not even in this way if there be ulcers of the cornea, as a deposit of acetate of lead on the ulcer is liable to occur. Tannin ointment :—Tannin gr. iii, vaseline ʒiii, the size of half a pea to be put into the eye once a day. Sulphate of copper ointment :—Same strength as the last, and to be used in the same way. Solution of alum :—gr. x to ℥i of distilled water; one drop in the eye once a day. Where an active pannus is present, a drop of solution of atropine should be instilled into the eye once a day as a precaution against iritis.

Some surgeons employ scarifications of the conjunctiva when it is much swollen and the papillæ too exuberant, but I have never adopted them, fearing the resulting cicatrices.

Again, it has been proposed to excise or abscise the granulations. This may, perhaps, be allowable if they are isolated and protrude much over the surface of the conjunctiva.

I have employed electrolysis, at the suggestion of Dr. George A. Walpole, for destruction of these growths in a few cases, with results which encourage me to further trials of the method. The negative pole, in the form of a needle, is plunged into the granulation, while the posi-

tive pole is placed on the temple or other adjacent region.*

Inoculation of the conjunctiva with pus from a case of blennorrhœa neonatorum has been much practised in Belgium, especially in cases of severe pannus. By this means a violent blennorrhœa is set up, which is then guided to a cure, and when it has subsided, the granular ophthalmia and pannus should have disappeared. Even where the pannus is well developed, this method must be attended with considerable danger to the cornea, and has not found general acceptance.

Infusion of jequirity, long used in the Brazils, has been introduced to the notice of European surgeons by de Wecker. The infusion is made by macerating the decorticised jequirity seeds in cold water (154 grains of the seeds to 16 ounces of water) for 24 hours. Three times a day for three days the lids are everted and the infusion thoroughly applied to the conjunctiva with a sponge. The result is a purulent ophthalmia of a somewhat croupous tendency (the cornea being hidden by a false membrane), accompanied by great swelling of the eyelids, much pain and considerable constitutional disturbance, rapid pulse, and temperature of 100° and more. In the course of eight or ten days the inflammation subsides, and the cornea in many cases will then be found to be free from pannus. There is little or no danger connected with the use of infusion of jequirity, severe as the resulting inflammation seems to be.

In addition to local remedies, it is of the utmost impor-

* Electrolysis has been employed by other ophthalmologists for the same purpose.

tance that the hygienic surroundings of patients suffering from granular ophthalmia be seen to, and that they be obliged to spend a considerable time daily in the open air.

If the upper lid be tightly pressed on the globe, for this pressure varies in different individuals, an impediment is offered to the cure, and pannus is promoted. It is then necessary to relieve the pressure by a canthoplastic operation.

Peritomy. This procedure is for the cure of pannus, by destruction of the vessels which supply it, and is as follows:—About 5 mm. from the margin of the cornea an incision is made in the conjunctiva with scissors, and carried at this distance all the way round the cornea. This ring of conjunctival tissue is then separated up from the sclerotic, and cut off at the corneal margin ; and the underlying connective tissue is dissected off the corresponding portion of the sclerotic, which is thus laid quite bare.

Acute Blennorrhœa of the Conjunctiva. In the commencement of this form of conjunctival inflammation there is great vascular injection and chemosis of the bulbar conjunctiva, serous infiltration of the palpebral mucous membrane making it tense and shiny, serous discharge, swelling of the eyelids, burning sensations in the eye, pain, and photophobia. The first stage lasts from 24 to 48 hours, and then begins the second stage, in which, owing to swelling of the papillæ, the palpebral conjunctiva becomes less shiny and more velvety, while the discharge alters from serous to the characteristic purulent form, the chemosis however remaining unaltered, or becoming more firm and fleshy. Gradually the

chemosis and swelling subside, and the discharge ceases, the mucous membrane being left in a normal state, unless in a small percentage of cases which become chronic. A severe attack lasts from four to six weeks.

Complications with corneal affections form the great source of danger of this affection. They occur in three different forms: 1. Small epithelial losses of substance on any part of the cornea. If these occur at the height of the inflammation they are apt to go on to form deep perforating ulcers. 2. The whole cornea becomes opaque (diffusely infiltrated), and towards its centre some greyish spots form, which are interstitial abscesses or purulent infiltrations. 3. The infiltration may form at the margin of the cornea, and extend a considerable distance around its circumference, giving rise to an ulcer, and later on to sloughing of the whole cornea. Corneal affections in blennorrhœa of the conjunctiva are due to strangulation of the blood supply of the cornea by the chemosis and by pressure of the tense eyelid, and to direct purulent invasion of the corneal tissue through superficial losses of substance.

Causes. Conjunctival blennorrhœa may be the sequence of a severe catarrhal conjunctivitis; or it may result from infection, direct or through the air, by purulent matter. As examples of direct infection, gonorrhœal ophthalmia (from the urethra by the finger) and blennorrhœa neonatorum (from the vagina during birth) are the most familiar.

Treatment. The only local application admissible during the first stage, in addition to antiseptic lotions, is ice compresses, which should be kept almost constantly applied to the outside of the eyelids. In this and in the

next stage the chemosis should be freely and daily incised with scissors. If the swelling of the lids be great, the external canthus should be divided with a scalpel from without, leaving the conjunctiva uninjured; by which means the tension of the eyelids on the globe is reduced, and, by bleeding from the small vessels, depletion of the conjunctiva is effected. Depletion alone can be obtained by leeching at the external canthus. If the chemosis, palpebral swelling, and rapidity of the onset, indicate that the inflammation is severe, it is, I think, well to place the patient quickly under the influence of mercury by means of inunctions, or small doses of calomel, as by this the chemosis is often rapidly brought down and one source of danger to the cornea removed.

In the second stage, *i.e.*, when the conjunctiva has become velvety and the discharge purulent, caustic applications are the most trustworthy, and in this respect iodoform or boracic acid cannot compete with them. The application employed may be a 15 to 30 grain solution of nitrate of silver, which should be applied to the everted lids as described when discussing the treatment of simple catarrhal conjunctivitis. Or, the solid mitigated nitrate of silver (one part nitrate of silver, two parts nitrate of potash) may be used, the first application being mild in order to test its efficacy, while careful neutralization with salt water and subsequent washing with fresh water are most important.

The immediate effect of a caustic application to the conjunctiva is the production of a more or less deep slough, under which a serous infiltration takes place. This latter increases and finally throws off the slough, and

then the epithelium begins to be re-formed. From the time the slough separates until the epithelium has been re generated, a diminution in the secretion may be noted; but the discharge again increases as soon as the regenerative period is ended, and this latter is the moment for a new application of the caustic. From one caustic application of ordinary severity until the end of the regenerative period about 24 hours usually elapse. Immediately after a caustic application iced compresses should be used for 30 minutes or longer. Very superficial scarifications of the palpebral conjunctiva immediately after the caustic application were employed by von Graefe, to give the patient ease and to promote the separation of the slough. No corneal complication contra-indicates the active treatment of the conjunctiva by the method just described; but when a corneal ulcer is present, care must be taken that during eversion of the lids no pressure is made on the eyeball, lest the floor of the ulcer give way.

When only one eye is affected, it is important to protect its fellow from infection by means of a hermetic bandage. This may be made by applying to the eye a piece of lint covered with boracic acid ointment, and over this a pad of salicylicated cotton wool. Across this, from forehead to cheek and from nose to temporal region, are laid strips of lint soaked in collodion in layers over each other; or a piece of tissue gutta percha may take the place of the lint and collodion, its margins being fastened to the skin by collodion. The bandage should be taken off every two or three days, or oftener, to examine the eye, lest the conjunctiva should be becoming affected, in which case it ought not be re-applied. The shields invented by

Maurel and by Buller are very serviceable for this purpose.

Corneal Complications may appear at any period of the progress of the inflammation, but the earlier they occur the more likely are they to result seriously.

Their treatment consists in the use of atropine, and, in case an ulcer threatens to perforate, paracentesis of the anterior chamber through the floor of the ulcer must be resorted to without delay. Those who believe in the power of the myotics to reduce the normal tension of the eye, employ solutions of pilocarpine or of eserine in place of atropine.

If an ulcer perforates spontaneously, the aqueous humour is evacuated, and, unless the ulcer be opposite the pupil and at the same time small in size, the iris must come to be applied to the loss of substance. Should the latter be very small, the iris will simply be stretched over it and pass but little into its lumen, and, when healing takes place, will be caught in the cicatrix which is but slightly, or not at all raised over the surface of the cornea, and the condition is called Anterior Synechia.

If the perforation be larger, a true prolapse of portion of the iris into the lumen of the ulcer takes place. This prolapse may either act as a plug filling up the loss of substance and keeping back the contents of the globe, but not protruding over the level of the cornea; or, it may bulge over the corneal surface as a black globular swelling, and may then play the part of a distensor of the opening, causing fresh infiltration of its margins. In either case cicatrization will eventually occur; and if the scar be fairly flat, it is termed an Adherent Leucoma, but

if it be bulged out, the term Partial Staphyloma of the Cornea is used.

If the perforation be very large, involving the greater part of the cornea with prolapse of the whole iris and closure of the pupil by exudation, the result is a Total Staphyloma of the Cornea. The lens may lie in this staphyloma, or it may retain its normal position but become shrunken.

The question of the treatment of a recent prolapse of the iris in cases of blennorrhœic conjunctivitis is an important one. It has been and still is largely the practice to abscise small iris protrusions down to a level with the cornea, or, if large, to cut a small bit off their summits with the object of obtaining flat cicatrices. Horner* has pointed out, that, in cases of blennorrhœa, this proceeding opens a way for purulent infection of the deep parts of the eye, and that serious consequences are not care. He confines interference with the iris in these cases to incision of the prolapse, when it seems to be acting as a distensor of the opening causing fresh infiltration of the cornea. Under other circumstances he restricts his treatment of the prolapse to the instillation of eserine, which has a marked effect in diminishing the size of the protrusion.

It will frequently occur, that, on the surgeon's visit to a case of blennorrhœa of the conjunctiva, he will find the margins of the eyelids gummed together by sero-purulent secretion, while the eyelids are bulged out by the pent-up fluid behind them. The attempt to open the eye should then be very cautiously made, lest some of the retained

* Gerhardt's *Handbuch der Kinderkrankheiten*, Bd. V. Abth. 2, p. 268.

pus spurt into the surgeon's eye. The surgeon should also be most careful to thoroughly wash and disinfect his hands and nails at the conclusion of his visit.

Blennorrhœa Neonatorum. The etiological element in this inflammation is almost invariably infection by abnormal secretion of the vagina finding its way into the eyes of the infant during the act of birth. For although the eyelids are closed during birth, they are not so tightly closed as to preclude the possibility of fluid making its way between them.

It commences on the third day after birth, the interval forming the stage of incubation. When it comes on some days later than this, it is due to infection from want of cleanliness on the part of the mother or her attendants.

The prevention of blennorrhœa neonatorum by suitable prophylactic measures is very important, and should form part of the routine of lying-in practice. Careful disinfection of the vagina before and after birth, and the minute cleansing of the face and eyes of the child with a non-irritating disinfectant immediately after birth are to be strongly recommended.

In cases of blennorrhœa neonatorum when the ulcer has been small, on perforation taking place, the lens, or rather its anterior capsule, comes to be applied to the posterior aspect of the cornea. The pupillary area is soon filled with fibrinous excretions. The opening in the cornea ultimately becoming closed, the iris and lens are pushed back into their places by the aqueous humour which has again collected. Adherent to the anterior capsule on the spot which lay against the cornea is a morsel of fibrin, which gradually becomes absorbed by the aqueous

humour. In the meantime changes have been produced by this exudation on the corresponding intracapsular cells, which result in a small, permanent, central opacity at that place, where there is also a slight elevation of pyramidal shape over the level of the capsular surface. This condition is called central capsular cataract, or pyramidal cataract, and rarely results from corneal perforation in adults.

The use of mercury in blennorrhœa neonatorum is not indicated, but in other respects its treatment is that above described.

Gonorrhœal Ophthalmia. This blennorrhœa is the result of direct inoculation of the conjunctiva with the urethral discharge, but there are no specific symptoms in the eye affection by which its origin can be recognized. It is frequently an extremely violent inflammation, requiring all the means at our disposal to combat it, and in many instances even our best efforts do not avail to save the eye. Its remarkable virulence is probably due to the micrococcus peculiar to gonorrhœal pus, which was discovered by Neisser * in the urethral discharge, and afterwards in the discharge from the conjunctiva in both these kinds of conjunctivitis—observations confirmed by other observers.

The treatment of gonorrhœal ophthalmia is that above laid down for acute blennorrhœa of the conjunctiva in general.

Croupous Conjunctivitis. This is chiefly found in children, and is not a common disease. The conjunctiva is a good deal swollen, and is covered with a false mem-

* *Centralblatt f. d. Med. Wissensch.* 1879, p. 497.

brane, that may be peeled off leaving a mucous surface underneath, which bleeds little or not all. The disease is not a severe one, and does not often cause secondary corneal affections. It must not be mistaken for diphtheritic conjunctivitis (*vide infra*).

Causes. Contagion. Epidemic.

Treatment. Iced applications during the croupous stage. Caustics are then very apt to cause corneal processes. Sæmisch recommends * sulphate of quinine to be dusted into the eye in this stage. When the false membrane ceases to be formed, a blennorrhœic stage comes on, which may be treated on the principles above laid down. Horner † is of opinion that in any stage of the affection little more than cleanliness is required.

Diphtheritic Conjunctivitis. There is no more serious ocular disease than this, for it may destroy the eye in 24 hours, while in severe cases treatment is almost powerless. The subjective symptoms of its initial stage are similar, although severer, especially in the matter of pain, to those of blennorrhœic conjunctivitis. The objective symptoms differ from those of blennorrhœa, in that the lids are excessively stiff from plastic infiltration of the sub-epithelial and deeper layers of the conjunctiva, while the surface of the mucous membrane is smooth, and of a greyish or pale buff colour. If an attempt be made to peel off some of the superficial exudation, the surface underneath will be found of the same colour, not red and vascular as in croupous conjunctivitis. This stage of infiltration lasts from six to ten days, and con-

* Graefe und Sæmisc *Handbuch der Augenheilkunde*, Bd. IV. p. 99.

† *Loc. cit.* p. 27

stitutes the period of greatest peril to the eye; for, while it lasts, the nutrition of the cornea must suffer, and sloughing of that organ is extremely apt to take place. Towards the close of the first stage the fibrinous infiltration is eliminated from the eyelids, and the conjunctiva gradually assumes a red and succulent appearance, and at the same time a purulent discharge is established. This constitutes the second or blennorrhœic stage. A third stage is formed by cicatricial alterations in the mucous membrane, which often lead to symblepheron or xerophthalmos; so that, even if the eye escape corneal dangers in the first and second stages, others almost as serious may await it in the final stage.

Corneal complications are most likely to occur in the first stage, and are then also most likely to prove destructive to the eye. The earlier they appear the more dangerous are they. If the blennorrhœic stage come on before corneal complications appear, or even before an ulcer contracted in the first stage has advanced far, they are more easily managed.

Causes. It is difficult to assign a cause for this disease. It is frequently epidemic, and is extremely infectious. It is very rare in these countries. In Ireland, where conjunctival diseases are so rampant, I have not seen a single case during an experience of fourteen years; while in Berlin it was so frequent that von Graefe set apart for it in his hospital two wards, which were for a length of time under my charge.

Treatment. Von Graefe's treatment of the first stage was actively antiphlogistic :—continuous ice compresses, local continuous depletion with a succession of leeches,

low diet, and active mercurialization. A tonic line of treatment with warm fomentations is now preferred.

In the second stage, careful caustic applications are to be used on the principles laid down (*vide* Acute Blennorrhœa of the Conjunctiva).

When the purulent discharge ceases, solutions of soda, milk, or glycerine may be prescribed, to avert if possible the xerophthalmos.

Conjunctival Complication of Smallpox. Of this I have, fortunately, too little experience to enable me to speak authoritatively. The following embodies the views of Professor Horner,* who studied the subject in the epidemic of 1871. A good deal of uncertainty prevailed previously, for the initial stages of the eye affection were not carefully observed by physicians, owing to the swelling of the eyelids, while the ophthalmologist saw only the results of the process in the period of convalescence.

Smallpox pustules on the cornea are, Horner believes, extremely rare, indeed he saw but one such case. The most frequent and most serious mode of attack consists in a greyish yellow infiltration in the conjunctiva close to the lower margin of the cornea, not extending to the fornix conjunctivæ, nor far along the inner or outer margin of the cornea, and occurring in the eruptive stage. It is to be regarded clinically as a variola pustule. This infiltration or pustule gives rise to a corneal affection, as does a solitary marginal phlyctenula, either in the form of a marginal ulcer, or as a deep purulent infiltration, ulcerating, perforating, leading to staphyloma, purulent irido-choroiditis and panophthalmitis;

* *Loc. cit.* p. 297.

results which are often first observed, long after the primary conjunctival affection has disappeared.

Horner thinks the germ of the conjunctival infiltration makes its way between the eyelids, and that the constancy of the position of the infiltration is accounted for by this theory; that part of the conjunctiva, with closed eyelids and consequently eyeball rotated upwards, being the most exposed to particles entering.

Treatment. On this ground he recommends the prophylactic use of boracic acid ointment on lint applied over the eyelids. If a conjunctival pustule has already formed, without any or only commencing corneal affection, he would destroy the pustule with fresh chlorine water or with mitigated lapis carefully neutralized. Corneal complications are treated as in blennorrhœa of the conjunctiva or diphtheritis.

The frequency with which the eyes become affected varies in different epidemics.

As true post-variolous affections, Horner recognises diffuse corneitis, iritis, and iridocyclitis, with opacities in the vitreous humour, and glaucoma. In the hæmorrhagic form of the disease, hæmorrhages in the conjunctiva and retina; and in pyæmic poisoning, septic affections of the choroid and the retina take place.

Amyloid Degeneration. This rare disease attacks chiefly the palpebral conjunctiva, but is also seen in the bulbar portion. It causes great tumefaction of the affected lid, without any inflammatory symptoms. The eyelid can be but partially elevated, and is often so stiff and hard that it can be everted only with difficulty. The conjunctiva has the appearance of white wax. The

disease ultimately extends to the cartilage, but is a strictly localized process, and not associated with amyloid disease in any other part of the system. It sometimes seems to be developed from granular ophthalmia, but occurs also as a primary disease. The positive diagnosis can be made by submitting a small portion of the diseased conjunctiva to the iodine test.

Treatment consists in removal of the diseased parts by the knife and scraping, so far as may be possible.

Xerosis or **Xerophthalmos**, is a dry lustreless condition of the mucous membrane, whitish grey epithelial scales coming away from it, while it is contracted in extent. The contraction may be ascertained by drawing down the under lid, when the inferior cul de sac will be found to have almost disappeared, and the degenerated conjunctiva to stretch across from the margin of the lower lid to the margin of the cornea. The cornea takes part in the process, its epithelium losing its lustre and causing defective vision.

Causes. Granular ophthalmia. Diphtheritic ophthalmia. Improper use of caustic applications. Conjunctival xerosis may also occur as a primary disease, especially in young children, and then leads to total destruction of the eye by ulceration of the cornea, etc., while the patients die of general malnutrition. In such a case Leber* demonstrated the presence of micro-organisms in the conjunctiva, and of similar bodies in the epithelium of the pelvis of the kidneys. A remarkable and yet to be explained association of night blindness with conjunctival xerosis is sometimes seen sporadically

* *A. v. Graefe's Archiv*, Vol. XXIX. part iii. p. 225.

or epidemically, the latter chiefly in foreign barracks and prisons. In this form of the affection similar bacilli have been found in the conjunctiva.

Treatment can only be directed to the palliation of the distressing symptoms caused by the dry condition of the conjunctiva. Collyrii of milk and glycerine, to which may be added some bi-carbonate of soda, are the most useful applications, and the eyes should be carefully protected from all irritating influences.

Pterygium. This is a vascularized thickening of the conjunctiva, triangular in shape, situated most usually to the inside of the cornea, sometimes to its outer side, and rarely either above or below it. The apex of the triangle is at the margin of, or on the cornea, and its base at the semilunar fold. There is frequently, but not always, a tendency of the growth to advance into the cornea, of which it seldom reaches the centre, and still more rarely extends quite across it.

Cause. The starting point of a ptergyium is generally an ulcer at the margin of the cornea, which in healing catches a morsel of the limbus conjunctivæ and draws it towards the cicatrix, throwing the mucous membrane into a triangular fold. The ulcer then forms anew in the cornea immediately inside the cicatrix, and in healing the point of conjunctiva is drawn into it again, and is carried a little farther into the cornea, and so on. The hollow lying between a pinguecula (see below) and the margin of the cornea is apt to lodge small foreign bodies, which cause shallow marginal ulcers, and these in healing draw the pinguecula over on the cornea.

Pterygium is a rare affection in this country, but is

more common in countries or localities where the air is filled with fine sand or other minute particles.

Treatment. Unless the pterygium be very thick and have invaded the cornea to some extent, or be progressing over the cornea, it is well to let it alone ; the more so as by removing it a quite normal appearance is not given to the eye, for a mark is necessarily left both on cornea and conjunctiva. If it be progressive, or very disfiguring, it should be removed, other proposed modes of dealing with it being futile. This may be effected either by ligature or excision.

In the method by ligature a strong silk suture is passed through two needles. The pterygium being raised with a forceps close to the cornea, one needle is passed under it here, and the other needle in the same way close to its base, the ligature being drawn half-way through. The thread is cut close behind each needle, thus forming three ligatures, which are respectively tied tight. In four or five days the pterygium comes away.

For excision the apex is seized with a forceps and dissected off either with a scissors or fine scalpel, care being taken not to injure the true cornea. The dissection is continued towards the base of the pterygium, where it is finished with two convergent incisions meeting at the base. The mucous membrane in the neighbourhood of the base is separated up somewhat from the sclerotic, and the margins of the conjunctival wound brought together with sutures.

Subconjunctival Ecchymoses. The rupture of a small subconjunctival vessel is of frequent occurrence. It suddenly gives a more or less extensive purple hue to

the "white of the eye," causing the patient much concern. It is common enough in old people, but may occur in the young, and even in children from severe straining, as in hooping cough, vomiting, or raising heavy weights. It is not of the slightest importance, doing no damage to the eye.

Treatment. If nothing be done, the extravasated blood gradually becomes absorbed, and the process may be hastened by the application of a tight bandage.

Pinguecula is the name given to a small yellowish elevation in the conjunctiva near the margin of the cornea, usually at its inner side, more rarely at its temporal margin, but sometimes in each place. It

FIG. 48.

contains, notwithstanding its name, no fat, but is composed of connective tissue and elastic fibres. It is supposed to be due to the irritation caused by small foreign bodies. It rarely grows to a large size, and requires no treatment unless it becomes very disfiguring, when it may be removed with forceps and scissors.

Polypus of the conjunctiva, for which it is difficult to assign a cause, is sometimes seen. It is generally small, in connection with the semi-lunar fold or caruncle, and can readily be removed with the scissors.

Dermoid Tumours. These are pale yellow in colour,

and in size from that of a split pea to that of a cherry. They are smooth on the surface and sometimes have fine hairs, and sit usually at the outer and lower margin of the cornea (Fig. 48), extending over somewhat on the latter. In structure they resemble that of the skin. They are congenital tumours, supposed to be due to an arrest in development, but often have a tendency to extend over the cornea. If this tendency be present, the tumour must be removed by dissecting it off the cornea, taking care not to go into the deep layers of the latter.

Lupus may occur as a primary disease of the conjunctiva,* or it may extend to the mucous membrane from the surrounding skin. It is seen as a patch or patches of small dark red protuberances or granulations chiefly on the palpebral conjunctiva, which bleed easily on being touched. They lead to cicatricial degeneration of the affected part, and are apt to spread over the mucous membrane. It may be mentioned here that Pagenstecher and Pfeiffer† have lately proved, by inoculation experiments, the tubercular nature of lupus.

The *Treatment* is scraping with a sharp spoon.

Primary Syphilitic Sores are sometimes seen on the conjunctiva, usually on its palpebral portion near the margin of the lid.

Secondary Syphilitic Sores also occur here. Their characteristic floors and sharply cut margins with the usual evidences of the constitutional disease suffice for the diagnosis.

Epithelioma is not common as a primary disease of

* Sattler. *Irish Hospital Gazette*, Feb. 16, 1874.

† *Berliner Klin. Wochenschrift*, May 7, 1883.

the conjunctiva. When it is so found, it is seen as a little tumour near the margin of the cornea surrounded by vascularization, and may in this stage be mistaken for a phlyctenula, of which however the margins are not so steep. As the tumour increases in size, it becomes lobulated and ulcerates and soon attacks the cornea.

Lithiasis consists in the calcification of the secretion of the Meibomian glands, which are seen as little brilliantly white spots not larger than a pin's head in the conjunctiva. There may be one only, or very many. These concretions often give rise to much conjunctival irritation, and if they protrude over the surface of the conjunctiva may injure the cornea. Each one must be separately removed by a needle, with which first an incision has been made into the conjunctiva over the concretion.

CHAPTER V.

PHLYCTENULAR, OR STRUMOUS CONJUNCTIVITIS AND CORNEITIS.

Both from a clinical and nosological point of view it would be incorrect to divide this affection into two, under the heads of Diseases of the Conjunctiva and Diseases of the Cornea, and therefore I propose to treat of it here as one disease.

Horner* terms it Eczema of the Conjunctiva and Cornea. It is characterized by the eruption of vesicles or pustules on the conjunctiva, on the corneal margin, or on the cornea, and is chiefly a disease of children up to the eighth or tenth year of age.

On the conjunctiva two types of the disease may be recognized :—

1. **The Solitary or Simple Phlyctenula.** Of this there may be one or several, varying in size from 1 mm. to 4 mm. in diameter. The vascular injection is immediately around the phlyctenula, and is not diffused over the conjunctiva. At first there may be shooting pains and tearing, but these soon pass away. If the phlyctenulæ be not seated close to the cornea, the affection is not serious; and the length of time required for its cure depends on the size of the phlyctenulæ, varying from 7 to 14 days as a rule.

* *Loc. cit.* Bd. V. Abth. 2, p. 279.

2. **Multiple or Miliary Phlyctenulæ.** These are minute, like grains of fine sand, and are always situated on the limbus of the conjunctiva, which is swelled. The general injection and swelling of the conjunctiva is considerable; and, occurring as it does almost exclusively in young children, in whom the ordinary conjunctival catarrh is rare, the affection may be called Eczematous Conjunctival Catarrh of Children (Horner). The irritation, and so-called photophobia, is often considerable, and there is a good deal of conjunctival discharge. This form is very apt to appear after measles and scarlatina.

Both forms are liable to extend to the cornea, and then only does the disease become serious. This event may come about in different ways.

The Solitary Phlyctenula may be seated partly on the limbus conjunctivæ and partly on the margin of the cornea, and may undergo resolution.

Or it may give rise to a deep ulcer, which either heals, leaving a scar, or perforates, causing prolapse of the iris, &c.

Or it may form the starting point of a progressive riband-like corneitis, the pustule becoming an ulcer, at the margin of which the corneal epithelium is raised and infiltrated in crescentic shape. This now steadily advances for many weeks towards the centre of the cornea, followed by a leash of vessels which has its termination in the concavity of the crescent. The process is accompanied by much irritation of the terminal branches of the fifth nerve in the cornea, and the consequent reflex blepharospasm. A permanent mark indicates the track of the ulcer.

The Multiple Miliary Phlyctenulæ on the limbus con-

junctivæ may cause some slight superficial infiltration and vascularisation of the cornea in their immediate neighbourhood, which passes off when the phlyctenulæ disappear.

Or, they may be accompanied by deeper marginal infiltrations of the cornea, which become confluent and result in an ulcer, which extends along the margin of the cornea for some distance, and is termed a Ring Ulcer. It is a serious form of ulcer, for if it extends far round, it may destroy the cornea in a few days by cutting off its nutrition.

Primary Phlyctenular Corneitis occurs principally in three different forms :—1. Very small grey subepithelial infiltrations which are apt to turn into small ulcers, and then heal, leaving a slight mark. The latter may ultimately quite disappear, especially if in children, and situated periphericaliy. 2. Somewhat larger and deeper infiltrations, resulting in ulcers of corresponding size, which heal by aid of vascularization from the margin of the cornea. The opacity left after these ulcers is rather intense, and clears up but little, especially if the situation be central. 3. Large and deep-seated pustules, often at the centre of the cornea, giving rise to large and deep ulcers, which may be accompanied by hypopion and even iritis, and which frequently go on to perforation.

Photophobia is usually a prominent symptom in phlyctenular corneitis. The term photophobia, however, is not correct, for it is the fifth nerve (from the cornea), which is the afferent nerve, and not the optic nerve. This is evident from the fact that, in the dark the patient does

not get relief; but if a sedative (atropine) be locally applied, he may generally be brought into the light without any annoyance. The explanation of this reflex blepharospasm has been given by Iwanoff,* who showed that the round cells, in making their way from the margin of the cornea to their position under the epithelium, follow the course of the nerve filaments, which they irritate in

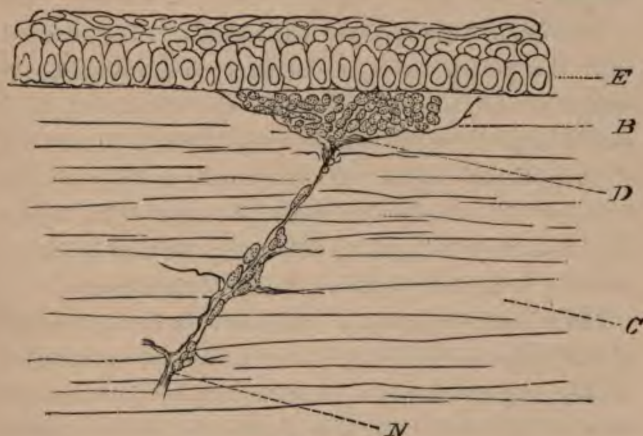


FIG. 49.

E. Epithelium; B. Ant. elastic lamina; C. True cornea; N. Nerve filament with lymph cells on its course; D. Phlyctenula.

their progress. The accompanying Fig. 49 is from his original paper.

Eczema of the eyelids, face, and external ear, and catarrh of the Schneiderian mucous membrane frequently accompany phlyctenular conjunctivitis and corneitis.

Cause. The strumous constitution, as indicated by

* *Klin. Monatsblätter f. Augenheilkunde*, 1869, p. 465.

the swollen nose and upper lip and sometimes by the enlarged lymphatics in the neck, as well as the eczema just mentioned, is that most liable to this affection. Often, however, it will be found in strong children with apparently perfect general health; but even in them there is probably some allied irregularity of nutrition, of which the great tendency to recurrence of the eye affection is evidence.

Treatment. The solitary phlyctenula is best treated with the yellow oxide of mercury ointment* (Pagenstecher's ointment), of which the size of a hemp seed should be put into the eye once a day. Or a small quantity of pure calomel dusted into the eye once a day will also cure, but this remedy should not be employed if iodide of potassium is being taken internally, for then iodide of mercury is liable to be formed in the conjunctiva.

The miliary phlyctenular conjunctivitis is best treated at first with cold or iced applications. Horner recommends freshly prepared Aq. Chlori. to be dropped into the eye once a day. Later on Liq. plumbi dil. or Sol. argent. nitr. (grs. v ad ℥i, and neutralized) applied to the everted conjunctiva are suitable, or if the phlyctenular appearances predominate over the catarrhal, the yellow oxide of mercury ointment or insufflations of calomel may be preferred.

When the cornea is slightly affected near the margin in cases of miliary phlyctenulæ, calomel or Pagenstecher's ointment and warm fomentations should be used.

* R.—Hydrarg. Perox. Præcip. gr. xxx. Vaselin, ℥i.—M.

NOTE.—Hyd. Perox. Præcip. is prepared by precipitating the Bichloride of Mercury with Liq. Sodæ, and washing the resulting oxide.

When a large pustule on the margin of the cornea has resulted in a deep ulcer with tendency to perforate and accompanied by much pain, the most reliable method of treatment is paracentesis of the anterior chamber through the floor of the ulcer, the pupil having first been brought well under the influence of eserine to prevent prolapse of the iris. The good effect of this will be very soon apparent: the pain disappears, the patient sleeps, the ulcer becomes vascularized, and healing sets in. Some recommend cauterization of the ulcer in an early stage with mitigated lapis or the galvano-cautery. Of this method I have no experience. Others trust very much to eserine, warm fomentations, and a pressure bandage.

For the fasicular corneitis the yellow oxide of mercury ointment is in its place. When the crescentic infiltration is very intense, Horner recommends it to be cauterized with the mitigated lapis. Division of the leash of vessels at the margin of the cornea has a beneficial effect.

For the ring ulcer, a pressure bandage under which an antiseptic dressing (boracic or salicylic acid or iodide of mercury) has been placed, is, perhaps, the best method of treatment. Warm fomentations promote vascular reaction, and may be used with benefit at each change of bandage.

For primary phlyctenulæ of the cornea in the form of the minute grey superficial infiltration or ulcer, nothing beyond atropine with warm fomentations and a protective bandage to keep the eyelids quiet should be used. When reparation of the ulcer has commenced, calomel or weak yellow oxide of mercury ointment may be employed.

For the large purulent phlyctenula resulting in a large

and deep ulcer often situated at the centre of the cornea with hypopion and iritis, in the commencement warm fomentations (camomile or poppy head at 90° F. for twenty minutes three times a day), atropine, iodoform as ointment or powder, and a protective bandage, is the treatment. Here also I often puncture the ulcer with the very best results in respect of hastening the cure. In the stage of reparation, Pagenstecher's ointment or insufflations of calomel are very useful.

In all forms of phlyctenular ophthalmia those favourite remedies blisters, setons, and leeching should be avoided. The first two worry the patient, give rise to eczema of the skin, and are not to be compared in their power of cure with the measures above recommended; while leeching gives at best but temporary relief, and deprives the patient of blood which he much requires.

For relief of the blepharospasm, in addition to the use of atropine, plunging the child's face into a basin of cold water and keeping it under until he struggles for breath, and this immersion repeated two or three times in rapid succession, and used every day if necessary, is a most efficacious means. It should always be used where the blepharospasm is severe, as this is not only distressing to the patient but an obstacle to the cure.

The general treatment should consist in open air exercise before everything else, unless indeed there be an ulcer which threatens to perforate. Cold or sea baths followed by brisk dry rubbing. Easily assimilated food at regular meal hours, but no feeding between meals. Regulation of the bowels. Internally: cod liver oil, maltine, iron syr., phosph. of lime, and such-like remedies are indicated.

The great tendency to recurrence is one of the most troublesome peculiarities of all kinds of phlyctenular ophthalmia; and in order to prevent this, so far as possible, it is important to continue local treatment until the eye is perfectly white on the child's awaking in the morning, and even for fourteen days longer. This prolongation of the treatment will also assist in clearing up opacities as best they may be. For this after-course of treatment calomel insufflations should be used. Nothing can be done for the opaque scars left on the cornea by ulcers when all inflammatory symptoms have subsided. If the ulcer has been superficial, the resulting scar in young children may disappear in the course of time. Deep ulcers cause more opaque and permanent scars, and ulcers which have perforated produce the greatest opacity. The defect of vision which an opacity of the cornea gives rise to, depends in the first place on its position. If this be peripheral the vision may be perfect, but if it be central, sight may be seriously damaged. Even a slight nebula, barely visible to the observer, will cause serious disturbance of vision if situated in the centre of the cornea, and in the same place the very opaque scar of a deep central ulcer will produce a proportionately greater defect. If a central, but not deep ulcer do not become completely filled up in healing, and a facet remain, vision will also suffer much in consequence of irregular refraction, although there may be but little opacity.

CHAPTER VI.

DISEASES OF THE EYELIDS.

ERYTHEMA, erysipelas, phlegmonous inflammation, and abscess are all liable to attack the eyelids, but require no special observations in this work. It should merely be stated that erysipelas of the eyelids may extend to the connective tissue of the orbit, and ultimately give rise to atrophy of the optic nerve.

Eczema. This is very often seen on the eyelids, most frequently either in connection with eczema of the face in general or with phlyctenular ophthalmia, which, as stated, Horner regards as eczema of the conjunctiva and cornea. The tearing in the latter affection increases the eczema, which then, by causing contraction of the skin of the lower lid, produces eversion of the inferior punctum lachrymale, and this in its turn causes increased epiphora, and thus a vicious circle is set up.

Treatment should consist in the daily removal of the scabs in such a way as to cause no bleeding of the surface underneath, and for this purpose a warm solution of bi-carbonate of potash is useful. The place should then be well dried and painted with a strong solution of nitrate of silver (gr. xx ad ℥i) and a boracic acid ointment (gr. xxx ad ℥i) applied over this. If the inferior

lachrymal punctum be everted, the canaliculus should be slit up.

Herpes Zoster Ophthalmicus is an herpetic eruption, which affects the region supplied by the supraorbital division of the fifth nerve of one side, and sometimes its nasal branch, and in rare instances the infraorbital division of the same nerve. The occurrence of the eruption is preceded for some days by severe neuralgic pain and swelling, with redness of the part. The number of vesicles varies much, and may be but three or four, or so numerous as to become confluent. As soon as the eruption appears the pain subsides. Vesicles are liable to form on the cornea, and these may result in ulcers, which, on healing, leave opacities. Iritis has also been observed as a complication, and even cyclitis, resulting in loss of the eye. The vesicles on the skin soon become purulent and gradually turn into scabs, that fall off, leaving deeply pitted scars, which are recognizable during the remainder of life. The affection never crosses the middle line of the forehead. Some neuralgia with anæsthesia of the skin often remain for a long time afterwards.

Inflammation of the Gasserian ganglion, with extension of the inflammatory process down the nerve, was found (O. Wyss) in the only case in which a *post mortem* examination has been made during the acute stage of the disease.

The affection is most common in elderly people, but I have seen it in young and healthy individuals.

The Treatment can only be expectative, or at most directed to relief of the patient's suffering, by means of hypodermic injections of morphium and other sedatives,

and by emollients applied locally. Complications with the cornea and iris are to be dealt with on the principles laid down in the chapters on the diseases of those organs.

Primary Syphilitic Sores occur on the lids, most commonly at the inner or outer canthus, or elsewhere on the margin where the skin becomes modified into conjunctiva. These sores are liable to cause marked loss of substance, and consequent distortion of the lid.

The Treatment should be an active antisyphilitic one, with local measures of a non-irritant nature, such as sublimed calomel by Kane's method, or dusting with finely powdered iodide of mercury.

Secondary Syphilis gives rise to ulcers on the margins of the lids, to loss of the eyelashes (madarosis), and to all the secondary skin affections which attend it in other parts of the body.

Rodent Ulcer (Jacob's Ulcer). This disease commences as a small pimple or wart on the skin near the inner canthus, or over the lachrymal bone as a rule, but it may also originate in any other part of the face. The scab or covering of the wart is easily removed, and underneath is found a shallow ulcer with a well-defined indurated margin, the skin surrounding the diseased place being healthy, and continuing so to the end of the chapter. The progress of the disease is extremely slow, extending over a great number of years, and in the early stages the ulcer may even seem to heal for a time, but always breaks out again. In mild cases the ulceration may remain superficial, but more usually it strikes deep, in the course of time eating away every tissue, even

the bones of the face and the eyeball. The latter is often spared until after the orbital bones have gone.

The disease is an epithelial cancer of a non-malignant, or purely local kind. There is no tendency to infiltration of the lymphatics. It is rarely seen in persons under 40 years of age.

Treatment. Extirpation of the diseased part affords the only chance of relief for the patient. Recurrence of the growth is the rule, but this should not deter from operative measures, nor even from renewal of them, as they afford much comfort to the patient, and prolong his life. Even in advanced stages operation is frequently called for. The application of chloride of zinc or of the actual cautery should be employed, after the disease has been as thoroughly removed with the knife as is possible.

Marginal Blepharitis (Ophthalmia Tarsi) is nothing else than eczema of the margin of the eyelid. It is found either as **Blepharitis Ulcerosa** (Eczema Pustulosum), or as **Blepharitis Squamosa** (Eczema Squamosa). In the former, small pustules form at the roots of the eyelashes, and these, losing their covering, become ulcers which scab over. The whole margin of the lid may then be covered with one large scab in which the eyelashes are matted, and under which the lid will be found swollen, red, and moist, with many minute ulcers and pustules. Many eyelashes come away with the scab, and many others are found loose and ready to fall out.

The disease is chronic, and most commonly found in strumous children. It is frequently accompanied by phlyctenular ophthalmia, or by simple conjunctivitis,

which may have been its cause, or which promote it, by keeping the margin of the lid constantly wet.

If neglected, ulcerous blepharitis is liable to produce distichiasis or trichiasis by giving a false direction to the bulbs of the ciliæ.

The Treatment of Ulcerous Blepharitis consists in careful removal of the scabs without causing any bleeding of the delicate surface underneath. Such bleeding indicates that the newly formed epithelium has been torn away, and it is important, therefore, to soften the scabs by soaking the eyelid with olive oil, or with a solution of bicarbonate of potash, before removing them. Any pustules found under the scab should be punctured, and all loose eyelashes taken away. The surface should then be well dried by pressure, not by rubbing with a soft cloth, and the following ointment (Hebra) applied:—℞. Ol. Rusci (or Ol. Juniperi) ʒss, Hydrag. Ammon. Chlor. gr. iv, Cer. Galeni ʒiv. This ointment is to be continued until healing is thoroughly established. In many mild cases a boracic acid ointment will be found efficacious instead of the above.

All complications with conjunctival affections or lachrymal obstruction must be dealt with, and the patient's general system carefully attended to.

Squamous Blepharitis comes on after the ulcerous form has passed away, or it is found as a primary affection, especially in chlorotic women. The margin of the lid is somewhat swollen and red, and covered with loose epidermic scales. It is an extremely chronic affection.

The Treatment of Squamous Blepharitis is also an ointment of Hebra's :—

℞. Emplast. Diachylon Co.*
Ol. Olivar, q.s.
Misce. Ft. Ung.

Chlorosis, if present, is to have suitable remedies.

Hordeolum (Stye), is a circumscribed purulent inflammation, situated at the follicle of a cilia. It commences as a hard swelling with more or less tumefaction of the general surface of the lid, and often with some chemosis, especially if it be situated at the outer canthus. In its early stages there is much pain associated with it. It gradually suppurates, and may then be punctured or allowed to open of itself. In the earliest stage cold applications may be successful in putting back a stye, but later on warm stupes will hasten the suppuration and relieve the pain. Styes frequently come in rapid succession one after the other, and then probably a constitutional disturbance exists as the cause. Habitual constipation is a common source of hordeolum, and should be met with the occasional use of Friederichshall or Hunyadi Janos water, or some other mild laxative. Sulphide of calcium, $\frac{1}{10}$ gr. every hour, or $\frac{1}{2}$ gr. twice a day for an adult, has been recommended (D. Webster) as a specific in these cases.

Chalazion, or **Meibomian Cyst,** is a retention tumour of a Meibomian gland. The sac of the tumour

* Emplast. Diachylon Co. is made as follows :—

Emplast. Litharg. B.P. 12 parts.
Corn flour, 1½ parts.
Ammoniac,
Galbanum,
Turpentine,
Of each 1 part.

consists of the walls of the gland, and its contents of the altered glandular secretion. These tumours vary much in size, from that of a hemp seed to that of a hazel nut, causing a marked swelling in the lid. They occasionally open spontaneously on the conjunctival surface.

Treatment. No application can bring about absorption of these tumours. The lid should be everted, the tumour opened from the conjunctival surface, and its contents thoroughly evacuated by aid of a small sharp spoon. Difficulty is sometimes experienced in finding the point in the conjunctiva corresponding to the tumour, but it is usually indicated by a dusky or greyish discoloration. Immediately after the evacuation, bleeding into the sac often takes place, and causes the tumour to remain for a day or more as large as before. The operation may occasionally require to be repeated two or three times. The incision and evacuation should never be made through the skin, because more or less disfigurement from the scar must result.

More than one chalazion is often present at a time, and some people become liable to them periodically during a number of years. Habitually constipated individuals are very subject to them.

Millium presents the appearance of a perfectly white tumour not much larger than the head of a pin, in the skin of the eyelid. It is a retention tumour of a sebaceous gland, and can readily be removed by puncture.

Molluscum, or **Molluscum Contagiosum.** This is a tumour in the skin of the eyelid, which may attain the size of a pea. It is probably a diseased condition of a sebaceous gland, and contains altered epithelial cells and

peculiar bodies termed molluscum corpuscles, which are of a fatty nature. At the summit is a depression, which leads to an opening into the tumour, and through which the contents can be pressed out. Many such tumours may form in the lids at the same time.

It is held by some observers that this affection is contagious, although in what way is not clear. Experimental rubbing of the contents of a molluscum into the skin has not given rise to the tumours.

Treatment. Each separate tumour must be evacuated by simple pressure, or after opening it up with a knife or scissors.

Teleangiectic Tumours, or **Nævi** of the eyelids occur congenitally. Small tumours of this kind may be destroyed by touching with nitrate of silver or hydrochloric acid, or by performing vaccination on them. Larger tumours may be ligatured, or treated with the galvano-cautery. Electrolysis is a very effectual method in many cases.

Xanthelasma is the term applied to yellowish plaques raised slightly over the surface of the skin, and with very defined margins. The shape of these plaques is extremely irregular, and they may attain the size of a shilling or larger. The appearance is caused by hypertrophy of the sebaceous glands with retention of their contents, and fatty degeneration of the subcutaneous connective tissue.

Treatment can only consist in removal by careful dissection, and this is hardly to be recommended, except in extreme cases.

Epitheliomatous and **Sarcomatous Growths** and **Lupus** are all seen in the eyelids, but require no special description here.

Clonic Cramp of the Orbicularis Muscle, or of a portion of it, is often seen, and is popularly known by the name of "life" in the eyelid. It is frequently due to over use of the eyes for near work, especially by artificial light, or if there be defective amplitude of accommodation.

Blepharospasm, or **Tonic Cramp of the Orbicularis Muscle** is commonly the result of irritation of the ophthalmic division of the fifth nerve by reflex action, as in phlyctenular ophthalmia and some other conjunctival affections, and with foreign bodies on the conjunctiva or cornea, etc., or it may continue for some time after the relief of any such irritation. It occurs, also, independently of such causes, and is then difficult to account for. In these latter cases pressure upon the supra-orbital nerve at the supra-orbital notch may arrest the spasm; or, if not there, then pressure on the infra-orbital, temporal, malar, or inferior alveolar branch may have the desired effect; or, at even still more remote regions, and in the course of other nerves the "pressure point" may be discovered. If found, treatment in the form of hypodermic injections of morphia at the "pressure point" may soon relieve the cramp, or subcutaneous division of the nerve at that place may be performed.

Ptosis, or **Blepharoptosis** is an inability to raise the upper lid, which then hangs down over the eyeball. Its most common cause is paralysis of the third nerve, of which a branch supplies the levator palpebræ. This branch alone may be paralysed, all the other muscles innervated by the third pair retaining their healthy action, and the degree of paralysis may be partial or

complete. Ptosis may also be congenital, and is then due to imperfect development of the levator muscle, and is generally present in both eyes. It is also caused by increased weight in the lid, as in many conjunctival affections, or where a tumour has formed in the eyelid, or where there is a hyper-development of the subcutaneous fat.

The causes of paralytic ptosis are similar to those of paralysis of other branches of the third pair.

Its Treatment too is the same, so long as there are hopes of restoring the power of the muscle by non-surgical interference.

Operative Treatment is indicated in cases of paralytic ptosis, in which other measures have produced no result, in ptosis adiposa, and in congenital cases. It consists in the excision of a sufficiently large oval piece of integument, its long axis lying in the length of the lid, with the subcutaneous connective tissues and fat, and, in paralytic cases, a small portion of the orbicular muscle. The fold of integument to be abscised should be seized by two pairs of forceps, one of them held by an assistant, at the inner and outer ends of the lid, and by this means the necessary size of the fold can be calculated. The abscision is performed with a pair of scissors, the margin of the wound lying close to the points of the forceps. The subcutaneous tissue, etc., is then removed, and the edges of the wound drawn together by a few points of suture.

Lagophthalmus, or inability to close the eyelids is most commonly due to paralysis of the portio dura, and is then associated with the other symptoms of the latter affection. On an effort to close the lids being made, the

eyeball is rotated upwards under the upper lid, owing to the associated action of the superior rectus; and in sleep this upward rotation also occurs, a fact which explains to a great extent the immunity of the cornea from ulceration in many of these cases. Lagophthalmus may also be due to orbital tumours pushing the eyeball forwards, to exophthalmic goitre, to staphyloma, or to intraocular growths distending the walls of the eyeball; in all of which conditions the eyelids are often mechanically prevented from closing over the eyeball, or can be closed only by a strong effort of the will. The danger to the eye depends upon the tendency to ulceration of the cornea from its dryness caused by exposure to the air, and from foreign substances not being removed from it by nictitation.

Treatment. In cases of non-paralytic lagophthalmus, protection of the cornea, by keeping the eyelids closed with a bandage or a few epidermic sutures in the margins of the eyelids, should be our first care. Tarsoraphy may be employed in those cases where circumstances indicate that it would be useful, *e.g.*, in some cases of exophthalmic goitre or of staphylomatous eyeball. In paralytic cases, the primary cause of the paralysis (syphilis, rheumatism, etc.) must be treated, so long as there is prospect of restoring power to the muscle. Locally, galvanism and hypodermic injections of strychnia may be employed. During cure the cornea should be protected as above. In incurable cases, the opening of the eyelids must be reduced considerably in size by an extensive tarsoraphy.

The Operation of Tarsoraphy consists in uniting the margins of the upper and lower lids in the neighbourhood of the external commissure, so as to reduce the opening of

the eyelids. The commissure should be caught between the finger and thumb and the edges of the lids approximated, so as to enable the operator to form an estimate of the required extent of the operation. A horn spatula is then passed behind the commissure, and the necessary length of the margin of each lid, including the bulbs of the ciliæ, abscised with a sharp knife. The raw margins are then brought together with sutures.

Symblepharon is adherence of the lid to the eyeball. It may be partial or complete, and is usually the result of burns by fire, acids, or lime. If the symblepharon interfere seriously with the motions of the eyeball, or if it cause defect of vision by obscuring the cornea, it becomes desirable to relieve it by operation. Should it consist of a simple band stretching from lid to eyeball it may be severed by ligature, or, if the band be broad, two ligatures may be employed, one for either half. A symblepharon which occupies a considerable surface cannot be got rid of in this way, and for such cases a transplantation procedure like that of Teale* or Knapp† may be employed, the great difficulty in dealing with these cases being the tendency there is to reunion of the surfaces, unless one or both of them be carpeted with epithelium. In Teale's operation, if we suppose the case to be similar to that represented in Fig. 50, an incision is carried along the line of the margin of the cornea at A, through the whole thickness of the symblepharon, and the lid is dissected off from the eyeball as far as the fornix. Two conjunctival flaps are now formed, as at B and C in

* *Ophthal. Hosp. Rep.* Vol. III.

† *Archiv f. Ophthal.* XIV. i. p. 270.

Fig. 51, and one of them (B) is turned to form a covering for the wounded surface of the inside of the eyelid, while the other (C) is used to cover the bulbar surface (Fig. 52), the flaps being held in their places by fine

FIG. 50.

FIG. 51.*

sutures. That part of the symblepharon which is left adherent to the cornea soon atrophies and disappears. No great tension of the flaps should exist as they lie in their new positions.

FIG. 52.

Teale again has suggested the formation of a bridge-like conjunctival flap above the cornea, and the removing of it across the latter to cover the loss of substance situated below. After the sutures to keep the flap in its place have been introduced the latter is separated at its bases.

* Mr. Teale now makes his flaps, as in Fig. 51, wider than he originally did.—I have to thank him for altering this drawing with his own hand.

The transplantation of a portion of rabbit's conjunctiva as suggested by Wolfe, or of a portion of mucous membrane from the lips or from the vagina as employed by Stellwag,* is undoubtedly the best method for most cases of extensive symblepharon. The chief precautions necessary for success in this proceeding are:—That the flap to be transplanted be not applied in its new position, until all bleeding at the latter place has ceased. That the flap be nothing more than mucous membrane, all submucous tissue being carefully removed. That it be sufficiently large to cover the defect without any stretching; and it should be remembered, that the flap shrinks to two-thirds of its size after being detached from its own bed. That the flap be kept moist and warm during the period, as short as possible, which may elapse between its detachment and its adjustment. And, finally, that it be kept firmly in its new position by a sufficient number of points of interrupted suture.

Blepharophimosis is a contraction of the outer commissure of the lids, with consequent diminution in size of the opening between the latter.

It is remedied by a *Canthoplastic Operation.* The outer commissure is divided in its entire thickness, in a line which is a prolongation of the line of junction of the lids when closed, by a single stroke of a strong straight scissors, one blade of which has been passed behind the commissure. The integumental incision should be made a little longer than that in the conjunctiva. An assistant then draws the upper

* *Die Propfung von Haut und Schleimhaut auf oculistischen Gebiete,* by Dr. E. Bock. Vienna, 1884.

lid up and the lower lid down so as to make the wound gape. The conjunctival margin and the dermic margin are now united in the centre by a point of suture (C. Fig. 53), while two more sutures (A and B) are applied, one above the other below the first. This operation is also employed in cases of granular ophthalmia and of purulent conjunctivitis, when it is desired to relieve the pressure of the lid on the globe.

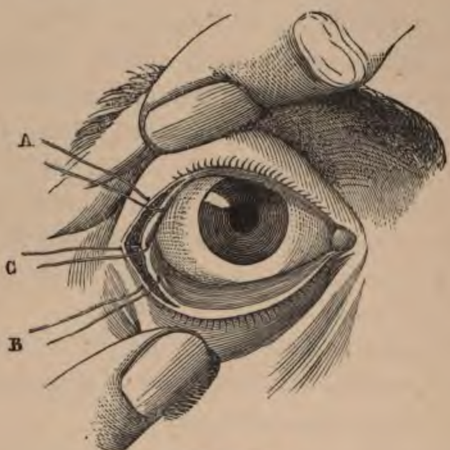


FIG. 53. (*de Wecker.*)

Distichiasis and **Trichiasis.** The first of these terms indicates the growth of a row of eyelashes along the inter-marginal portion of the lid in addition to the normal row, while trichiasis indicates a false direction given to the true ciliæ. Both conditions are often found co-existing, and they are also often present along with entropium. They may both be produced by chronic blepharitis, or by chronic granular ophthalmia. The

symptoms to which they give rise, and the dangers to the eye attendant on them are due to the rubbing of the irregular eyelashes on the cornea, which produces pain, blepharospasm, and opacity of the cornea, or even ulceration of it.

Operations for Distichiasis and Trichiasis. 1. Epilation. The false ciliæ may be pulled out with a forceps; but this cannot be regarded as a cure, for the hairs grow again.

2. Electrolysis has been proposed by Dr. Charles Michell, of Missouri,* and by Dr. A. Benson, of Dublin.† A needle is attached to the negative pole and its point passed into the bulb of the eyelash to be removed, the positive pole being placed on the temple. On closure of the circle a slough is formed at the root of the hair, which becomes loose and is removed. It does not grow again, for the bulb is destroyed. Each hair must be separately operated on, and the proceeding is very valuable where only a few ciliæ are to be dealt with.

3. When some half dozen hairs close together are growing wrong, the simplest and best plan is to completely remove them by excision of the corresponding portion of the ciliary margin. A fine knife is passed into the intermarginal region at the place corresponding to the hairs to be dealt with, and a partial division of the lid into two layers, as in the Arlt-Jaesche operation (*vide infra*), is effected. A **V**-shaped incision in the skin of the lid is then made including the erring hairs, the whole flap is

* *Trichiasis and Distichiasis, their Nature and Pathology, with a Radical Method of Treatment;* and *Klin. Monatsbl.* April, 1882.

† *Brit. Med. Journal*, 16 Dec. 1882.

excised, and the margin of the loss of substance drawn together with sutures.

In cases of distichiasis or trichiasis involving the whole length of the eyelid, removal of the marginal portion of skin containing the bulbs of all the eyelashes true and false (Flarer's operation) is not to be recommended, unless occasionally in the underlid; because it unnecessarily deprives the eye of an ornament and of a protection against glare of sun and foreign bodies.

FIG. 54.

4. In these complete cases transplantation of the marginal portion of the integument containing the hair bulbs, true and false, is a much preferable proceeding. One of the oldest and most valuable operations of this kind is that of Jaesche, modified by Arlt. It is performed as follows:—Knapp's or Snellen's clamp (Fig. 54) having been applied to prevent bleeding, the lid in its whole length is divided in the intermarginal part into two layers (Fig. 55), the anterior containing the orbicular muscle and integument with all the hair bulbs, the posterior containing the cartilage and conjunctiva. The incision in the inter-marginal portion is about

5 mm. deep. A second incision is now made through the integument of the lid parallel to its margin, and from 5 to 7 mm. removed from it. This incision also extends the whole length of the lid. A third incision is carried in a curve from one end to the other of the second incision. The height of the curve is proportional to the effect required, varying from 4 mm. to

FIG. 55.

7 mm. The piece of integument included between the second and third incisions is dissected off with forceps and scissors, without any of the underlying muscle being touched, and the margins of the loss of substance are brought together by sutures. By this procedure the lower portion of integument containing the hairs and their bulbs is drawn up and away from contact with the cornea.

Spencer Watson,* Nicati,† Schoeler,‡ Burchard,§ Dianoux,‖ and Gayet,¶ have all proposed double transplantation operations.

Dianoux's Operation is as follows:—Snellen's (or de Wecker's) clamp is applied (omitted in figures for simplicity) and an incision (Fig. 56) is made parallel to the free margin of the lid, about 4 mm. from it, extending the whole length of the lid, and penetrating to the cartilage, but not through the latter. The ciliary portion of

FIG. 56.

the lid marked off by this means is now detached from the cartilage by an incision on the intermarginal portion of the lid as in the Arlt-Jaesche operation. An incision through the skin alone is then made about 3 mm. above the first incision and parallel to it, but extending some 2 mm.

* *Ophthal. Hosp. Rep.* Vol. VII. 1873, p. 440.

† *Marseille Médicale*, 1879.

‡ *Klinischer Bericht*, 1880.

§ *Charité Annalen*, p. 633.

‖ *Annales d'Oculistique*, 1882, p. 132.

¶ *Ann. d'Ocul.* 1882, p. 27.

beyond it at either extremity. The skin flap is separated off from the underlying muscle, except at either end where it is left attached. The underlying portion of the muscle is then separated from the cartilage, and allowed to retract upwards. A forceps being passed under the ciliary flap (Fig. 56) the skin flap is seized and drawn down into the position of the former (Fig. 57), where it is made fast by three sutures to the margin of the cartilage. The ciliary flap is moved up and carefully stretched upon the cartilage bared of the orbicularis, which latter is drawn back with a strabismus hook, and the flap is secured in

FIG. 57.

its place by sutures to the tarsus. An antiseptic dressing is applied, and the sutures may be removed on the third day. The wounded surface of the ciliary flap amalgamates with the epidermic surface of the skin flap so completely, that in the course of a short time it is impossible to separate them, and ultimately nearly all traces of the operation disappear.

Illaqœtio. Snellen has revived this ancient operation, for cases where only a few isolated hairs are out of order. Both ends of a bit of very fine silk thread are passed

through the eye of a fine needle so as to form a loop. The needle is now entered as close to the point of exit of the hair as possible, and the counter puncture is made in the position which the hair should normally occupy in the row of its fellows. The needle is drawn completely through, as also the ends of the thread, but the loop not as yet. Into the loop the eyelash is now inserted by aid of a fine forceps, and, by traction on the ends of the thread, loop and eyelash are drawn through the tunnel.

Entropium, or **Inversion of the Eyelid** is due to some organic change in the conjunctiva or tarsus, or to spasm of the palpebral portion of the orbicular muscle. A large proportion of the former class of cases is the result of chronic granular ophthalmia, and is most common in the upper lid. Spastic entropium usually occurs in the under lid. It is frequent in old people (senile entropium) from relaxation of the skin of the eyelid, and is also produced by the wearing of a bandage after operations, &c., and by œdema of the conjunctiva in inflammation of that membrane.

Organic entropium, in which the cartilage is not distorted, can for the most part be corrected by one of the methods described for trichiasis and distichiasis. But many of these cases are accompanied by, or rather are due to curvature with hypertrophy of the cartilage of the lid.

In all such cases the operation must include an attack on the cartilage itself, or the result will be abortive. Indeed, I have little doubt but that much of the disappointment experienced in the treatment of entropium has been due to imperfect appreciation of this fact.

Streatfield's Operation is as follows:—The clamp

having been applied, an incision is made through the integument of the eyelid parallel to its margin, 2 mm. distant from the latter, and extending its whole length. The muscle is dissected up so as to lay bare the cartilage, and a wedge-shaped piece, 2 mm. wide and the length of the lid, its edge pointing towards the inner surface of the lid, is excised from the cartilage. A corresponding portion of muscle and skin is also removed, and the wound left to heal by granulation. The shrinking of the resulting cicatrix causes the marginal portion of the cartilage to return to its correct position.

Snellen's Operation. Snellen's clamp (very similar to Knapp's, which can equally well be used) is applied. About 3 mm. from the margin of the lid and parallel to it an incision is made through the skin alone, extending the whole length of the lid. The orbicular muscle is exposed by dissection of the skin upwards in order to promote retraction of the latter, and along the edge of the lower margin of the wound a strip of about 2 mm. broad of the orbicular muscle is removed, and the cartilage to the same extent exposed to view. A wedge-shaped piece corresponding to the exposed parts of the tarsus is now excised from it with a very sharp scalpel or Beer's cataract knife, the edge of the wedge pointing towards the conjunctiva, which latter, however, is left intact. The hypertrophy of the cartilage which is always present facilitates this procedure. A silk suture carrying a needle on each end having been prepared, one needle is passed from within outwards through the band of muscle and integument left at the margin of the lid. The second needle is also passed from within outwards through the

upper lip of the tarsal loss of substance, and then, from within outwards through this same marginal band, at a

FIG. 58.

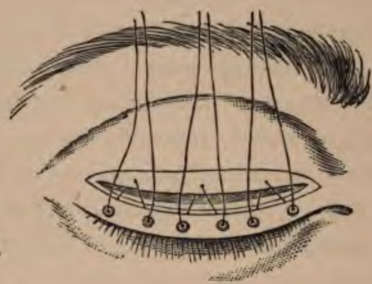


FIG. 59.

distance of about 4 mm. from the point of exit of the first needle. The ends of the suture are now tied together, a small bead having first been strung on each to prevent it from cutting through the skin. Three such sutures are employed. The accompanying woodcuts (Figs. 58 and 59) from de Wecker * make the foregoing description more intelligible.

Berlin's Operation. Knapp's clamp is applied. The first incision lies 3 mm. above the margin of the lid, extends its whole length, and divides it in its entire thickness, including the conjunctiva. The skin and muscle at the upper edge of the wound are pushed or dissected up, so as to expose the cartilage. The upper edge of the tarsal incision is now seized at its centre with a finely toothed forceps, and an oval piece with the adherent

* *Traité Complet d'Ophthalmologie*, par L. de Wecker et C. Landolt. T. I. p. 214.

conjunctiva, about 2-3 mm. wide in its widest part and in length corresponding with that of the eyelid, is excised from it with a fine scalpel. The wound is closed with three sutures through the skin. If it be thought desirable to increase the effect, a skin-flap may be excised from the lid. The objection to this operation, that a portion of the mucous membrane is removed, is not of importance. Except for an occasional granulation forming on the bulbar aspect of the wound, I have found the operation free from inconvenience, and its result satisfactory and permanent.

Spasmodic Entropium as the result of bandaging usually disappears when the use of the bandage is given up, or, if the bandage must be continued and the inverted lid cause irritation, an epidermic suture at the palpebral margin and fastened to the cheek below will give relief.

Senile Entropium is, of spastic kinds, the one which most commonly demands operative interference. The methods in general use for it are:—

The Excision of a Horizontal Piece of Skin, with a portion of the underlying orbital part of the orbicular muscle, so as to give rise to sufficient cicatricial contraction to draw the margin of the lid outwards.

The application of *Subcutaneous Sutures* (*Gaillard's Sutures*):—The point of a curved needle carrying a silk suture is entered in the centre of the lid near its margin, passed deeply into the orbicular muscle, brought out at a point some 10 mm. below, and the suture tied tightly. Two more similar sutures, one on either side of the first and about 5 mm. distant from it, are placed, and the re-

sulting suppuration with consequent cicatrisation brings the lid into its position.

Graefe's Operation :—3 mm. from the margin of the lid an incision is made, as in Fig. 60, through the skin, and a triangular skin flap, A, excised. The edges, B and C, of the triangle are dissected up a little, and brought together by three points of suture, while the horizontal incision is not sutured. The size, especially the width of the triangular flap to be excised, is proportional to the looseness

FIG. 60. (*v. Graefe.*)

of the skin. When a very marked effect is desired, the flap to be removed is given the shape as represented at the right of the figure. I have found this proceeding extremely satisfactory, and its result permanent.

All the foregoing, and other such measures produce a good result at the time, but are sometimes followed by recurrence of the entropion. Hotz * believes the cause of this to be, that the cicatrix, be it dermic or dermo-muscular, upon which the result depends, has no *point d'appui*, and,

* *Klin. Monatsbl. f. Augenh.* 1880, p. 149.

while it may draw the eyelid out, it is just as liable to draw the skin of the cheek up, and thus neutralise its desired effect. He proposes the following ingenious operation :—

Hotz' Operation. A horn spatula is inserted under the lid, and then at 4 to 6 mm. below the margin of the latter a horizontal incision is made through the skin from the inner to the outer end of the lid. This incision is at the boundary between the palpebral and orbital portions of

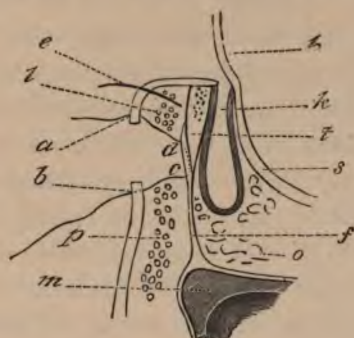


FIG. 61. (*Hotz.*)

the orbicular muscle, and just over the lower margin of the tarsus. An assistant then draws the upper edge (*a*) of the wound upwards with a forceps, while the surgeon draws the lower edge (*b*) downwards, in this way exposing and stretching the orbicular muscle. A few strokes of the knife in the direction of the incision are now sufficient to separate the palpebral portion (*l*) of the muscle from the orbital portion (*p*), and to lay bare the lower edge of the tarsus (*t*), which has a yellowish tendinous appearance. That part of the palpebral portion of the muscle which

covered the lower edge of the tarsus, and which was drawn up with the palpebral edge of the first incision, is now removed with forceps and scissors to the extent of about 2 mm. in width through the whole length of the lid. All such muscular fibres also which may still adhere to the lower third of the tarsus must be carefully cleaned off, and now the palpebral skin may be brought into union with the tarsus. Four sutures are generally applied about 5 mm. apart. The needle is passed through the palpebral skin, close to the margin of the wound (at *a*). The bare tarsal edge is then seized in the forceps, the needle placed perpendicularly on it (at *d*), and carried through it by a short downward curve, until its point appears (at *c*) below the tarsus in the tarso-orbital fascia (*f*). The needle is now passed out through the lower edge of the incision (at *b*), care being taken that none of the fibres of the orbital portion of the muscle are included in the suture. Upon the suture being tightly closed the edges of the skin wound are drawn into the tarsus, and become adherent to it. The sutures may be removed about the third day. If the first incision be placed too far from the margin of the lid, there will be no result, as the traction upon the palpebral skin will be too slight. If the incision be placed too close to the margin, the traction may be so great as to interfere with the union of the skin and tarsus. In this operation the tarsus affords the fulcrum which Hotz thinks is wanting in the other methods.

Ectropium or **Eversion of the Eyelid.** Of this there are two chief kinds. 1. Muscular. 2. Cicatricial.

Muscular Ectropium may be caused by œdema of the

conjunctiva, which everts the edge of the eyelid, and this eversion is increased and encouraged by spasm of the palpebral portion of the orbicular muscle, so that the name palpebral paraphimosis has been given to the condition. In the recent stage it may generally be remedied by a properly applied bandage, combined with the suitable conjunctival measures. In chronic cases Snellen's sutures (*vide infra*) may be required. Muscular ectropium is often seen in old people, and is then given the name of senile ectropium. Here it is due to atrophy of the palpebral portion of the orbicularis and relaxation of the skin of the face. When these have resulted in slight eversion of the inferior punctum, a flowing of tears is produced, and from this excoriations of the skin and edge of the lid come on, which in their turn increase the tendency to ectropium. If the condition be not extreme with secondary changes in the conjunctiva, slitting up of the canaliculus, with the use of a boracic ointment for the lids and mild astringents for the conjunctiva, will give much relief. In pronounced cases a more active treatment of the conjunctiva, and the performance of tarsoraphy, the latter preceded by the application of Snellen's sutures, is demanded. Muscular ectropium is also caused by paralysis of the orbicular muscle.

Snellen's Sutures. A silk ligature is threaded at either end with a needle of moderate size and curve. The point of one of these needles is passed into the most prominent point of the exposed and everted conjunctiva, and brought out through the skin 2 cm. below the edge of the lower lid. The other needle is entered in the same way 5 mm. from the first, and made to take a nearly parallel course,

the points of exit on the cheek being 1 cm. apart. Equal traction is applied to each end of the suture, while the lid is assisted into its place by the finger. The suture is tied on the cheek, a small roll of sticking plaster having been inserted under it to protect the skin from being cut. Two, or even three such sutures may be required.

*Argyll Robertson's Operation** has been designed for those cases of ectropion which result from long-continued chronic inflammation of the conjunctiva of the lower lid. He thinks the difficulty in severe cases of this kind depends upon the abnormal curvature which is gradually acquired by the tarsal cartilage. The following is his description of the operation, from which he has obtained satisfactory results :—

The materials required are—

1*st.* A piece of thin sheet-lead about 1 inch long and $\frac{1}{4}$ inch broad, rounded at its extremities, and with its cut margins smoothed. This piece of lead must be bent with the fingers to a curvature corresponding to that of the eyeball.

2*nd.* A waxed silk ligature about 15 inches long, to either extremity of which a long moderately curved needle is attached.

3*rd.* A piece of fine india-rubber tubing (the thickness of a fine drainage tube).

The operation is performed by perforating the whole thickness of the lid with one of the needles at a point (*b*) one line from its ciliary margin, and a quarter of an inch to the outer side of the centre of the lid. The

* *Edinburgh Clinical and Pathological Journal,* Dec. 1883; and *Ophthal. Rev.* Feb. 1884.

needle having been drawn through (at *a*), is passed directly downwards over the conjunctival surface of the lid, till it meets the fold of conjunctiva reflected from the lid on to the globe through which the needle is thrust—the point being directed slightly forward—and pushed steadily downwards under the skin of the cheek until a point (*d*) is reached about 1 inch or 1¼ inches below the

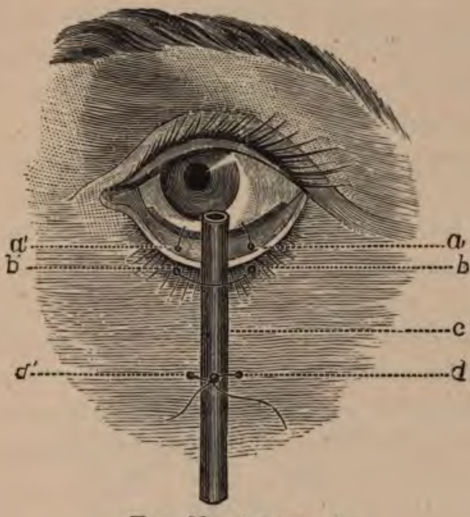


FIG. 62. (*A. Robertson.*)

edge of the lid, when the needle is caused to emerge, and the ligature is drawn through. The other needle is in like manner thrust through the edge of the lid at a corresponding point (*b'*) a quarter of an inch to the inner side of the middle of the lid, then passed over the conjunctival surface of the lid, through the oculo-palpebral fold of conjunctiva, and downwards under the skin till

the point emerges at a spot (*d′*) a quarter of an inch outwards from the point of emergence of the first needle (*d*). The ligature is kept slack, or is slackened so as to permit of the piece of lead being introduced under the loops of the ligature that pass over the conjunctival surface of the lid, and of the piece of india-rubber tubing (*c*) being slipped under the loop at the edge of the lid (between *b* and *b′*). The free ends of the ligature are now drawn tight, and tied moderately tightly over a lower part of the india-rubber tube. The excess of india-rubber tube is cut off—about a quarter of an inch beyond the ligature—and the operation is complete.

The result of the procedure is that the edge of the lid is made to revolve inwards over the upper edge of the piece of lead, while the tarsal cartilage is caused to mould itself to the curve of the lead, and the eyelid at once occupies its normal position. A certain amount of redness and œdema of the lid follows the operation, and suppuration occurs in the track of the ligature; but, as the india-rubber tube yields somewhat to the tension on the ligature, the irritation resulting is moderate, so that the apparatus need not be removed for five, six, or seven days, by which time the cartilage has become pretty well fixed in its new curvature. A slight relapse may occur when the apparatus is removed, but this is readily amenable to treatment by astringent applications.

The suppuration occurring in the tracks of the ligature leads to cicatricial formation, which appears to impart a degree of rigidity to the lid which helps to keep it in its new position.

Cicatricial Ectropium is caused by scars from wounds

or burns, or from caries of the orbit, and can only be cured by operation.

Mr. Wharton Jones' Operation is as follows:—The cica-

FIG. 63. (*de Wecker.*)

trix is circumscribed by a V-shaped incision (Fig. 63), and is excised, and the skin made thoroughly moveable in

FIG. 64. (*de Wecker.*)

its neighbourhood. The edges of the wound are now brought together so as to form a Y (Fig. 64.)

Arlt's Operation, for cases due to caries of the margin of the orbit. If the cicatrix be situated at *e* (Fig. 65), the incisions at *a b* and *b c* are made through the skin and muscle, so that an acute or at most a right angle is formed at *b*. The margin of the lid from *c* to *d* is excised. The cicatrix is completely undermined, and the triangle dissected up from *b* to the margin of the tarsus, so that the lid can be readily put into its position, and the edge *c b* of the flap united to *d c*. The size of the exposed surface on the cheek can, according to Arlt, be diminished by

FIG. 65. (*Arlt.*)

drawing its edges together after the manner of a hare-lip, but possibly the transplantation of a piece of skin from the arm to fill the gap might be a better plan.

The foregoing and similar operations are difficult or impossible in many cases, where there has been great destruction of the skin of the eyelids and surrounding parts by burns, ulcers, etc., and at best the deformity is liable to recur. Transplantation of skin from distant parts is in these cases a more promising proceeding. A description of the method is given in the following paragraph.

The Formation of an Eyelid. One or both eyelids may be destroyed by a burn, lupus, etc., and the consequent exposure of the eye is liable to produce ulceration of the cornea. It is then necessary to provide a covering for the eye. Many ingenious plastic operations have been proposed for this purpose, but they all have the disadvantage of leaving disfiguring scars in the forehead or cheek, while, if they fail, they hardly can be repeated; and, finally, there are many cases in which, owing to destruction of the surrounding skin, these procedures are quite inapplicable. On the other hand, the formation of an eyelid by a dermic graft or transplantation of skin without pedicle from a distant part, is free from all of these disadvantages, and will probably take the place of those complicated operations which I need not here describe.

It may be pointed out, that Reverdin's original method of skin grafting is an admirable means whereby the luxuriant granulating surfaces produced by a burn may be prevented from turning into great contracting cicatrices, drawing the neighbouring parts out of position.

*De Wecker's Method of Grafting.** If both eyelids be supposed to be destroyed, the margins of the skin around the orbit are revivified, and a band of skin, etc., from 1½ to 2 cm. wide is formed all round by two curved incisions which unite at the temple. This band is made sufficiently free to admit of a ready coaptation of its revivified margins, which are united by a series of metallic sutures. The raw surfaces are then completely covered with a mosaic of cutaneous morsels, from 1½

* *Chirurgie Oculaire*, p. 389.

to 2 cm. square, each one most carefully stretched and brought into accurate contact with the underlying surface by aid of a blunt probe. The whole is covered with goldbeater's skin, on which again is laid a boracic dressing. In forty-eight hours those grafts which have become adherent present a pinkish hue, those which do not adhere become pale and necrosed. If necessary, a few fresh grafts can be applied later on to the granulating surface, where some of the first grafts may not have become adherent. De Wecker claims for this method the advantage, that these many small grafts accommodate themselves better to the various irregularities of the surface, than does one large flap covering the whole. The patient's forearm is the most convenient place from which to take the required skin.

The grafts must be quite free from subcutaneous connective and adipose tissue, and every possible antiseptic precaution should be adopted.

Lefort, Wolfe, and others employ flaps of 12 cm. and more, which they graft *in globo* on the raw surface. Ed. Meyer lays such a flap to be grafted, with its epidermic surface down, on a warm plate, and carefully removes all fat and connective tissue. It is then laid on the defect and secured by sutures to the margin of the latter. Folds in the applied graft are, Meyer thinks, of no consequence, but any tension is bad, and it should be remembered in preparing the graft that it shrinks to two-thirds or half its size after removal from the arm or elsewhere. The dressing is the same as in De Wecker's method, and antiseptic precautions are equally necessary. The bandage is not changed for four or five days, and then half of the

sutures are removed, the remainder two days later. The epidermis of the graft always comes away.

In these methods it is most important to preserve and utilize any part of the eyelid which remains, especially its ciliary border with the eyelashes.

Injuries of the Eyelids. Incised wounds of various kinds may occur without injury to the eyeball, or in conjunction with the latter. Their treatment requires no special description.

Ecchymosis of the eyelids from blows, commonly known as 'Black Eye,' never gives rise to further complication. It requires some 14 days or more, according to the quantity of blood extravasated, before the eye recovers its normal appearance. Immediately after the blow, and for some twenty-four hours, iced compresses moistened with the following lotion are of use to prevent or subdue swelling and assist in diminution of the disfigurement. ℞. Tinct. Arnicæ ʒiv, Liq. Ammon. Acet. ℥i, Aq. destill. ad ℥viii. At a later period no application can be of much benefit.

Epicanthus is a congenital deformity consisting in a fold of integument which conceals the inner canthus and caruncle from view. It is usually associated with a flat bridge to the nose, and, if not of extreme degree, may disappear as the latter becomes developed. Where this does not occur, the deformity can be much diminished by the removal of an oval piece of skin from the bridge of the nose, its long axis perpendicular and its width depending on the effect required. The margins of the wound are united by sutures.

CHAPTER VII.

DISEASES OF THE LACHRYMAL APPARATUS.

Malposition of the Punctum Lachrymale.* Inversion of the punctum accompanies entropium of the eyelid, while eversion of it is present with ectropium of the lid. A slight eversion, quite sufficient to cause tearing, may exist without any marked ectropium of the lid, and it is these cases which more properly belong to this chapter. They are the result generally of some chronic, although it may be slight skin affection of the lower lid, which draws the inner end of the latter a little away from the eyeball.

The prominent symptom of this and of all the following lachrymal affections is a flowing of tears over the cheek. The usual term for this symptom is Epiphora, although Stillicidium lachrymarum is undoubtedly the more correct one.

Stenosis, and **Complete Occlusion of the Punctum Lachrymale.** Either of these conditions may result from conjunctivitis or from marginal blepharitis, although

* In this chapter, and elsewhere in the book, the terms "punctum lachrymale" and "canaliculus" refer to the inferior passage, unless it be otherwise expressly stated.

they may not appear for a length of time after those affections have passed away. In stenosis, the size of the punctum may become so extremely minute, that even the normal flow of tears is too great to make its way through it. Complete occlusion is probably only a more advanced stage of stenosis.

The Treatment, both in cases of eversion of the punctum and in stenosis and complete occlusion, is similar, namely, the opening up of the punctum and its conversion into a slit. This is done with a Weber's knife (Fig. 66), the probe-point of which is passed into the punctum in cases of eversion, forced into the small opening in cases of stenosis, or forced through the usually thin covering of the punctum in cases of occlusion. In doing this, the lower lid should be stretched tightly by a finger of the surgeon's left hand placed near the external canthus. The edge of the knife being now directed towards the eyeball, the instrument is pushed on a little into the canaliculus, until 2 mm. of the latter have been opened up, and it is then withdrawn. If the edge of the knife be directed outwards in this proceeding, the incision comes to lie on the outer edge of the inter-marginal portion of the lid, and not in contact with the eyeball; consequently, the tears are not carried away, and the disfigurement produced is considerable. A slitting up of the whole or the greater part of the canaliculus in these cases is unnecessary, and interferes

FIG. 66.

with the physiological action of the tear passage. For two or three days after the little operation it is necessary to pass a probe along the portion of the canaliculus which has been slit up, to prevent union by first intention.

Obstruction of the Canaliculus. The canaliculus may be diminished in its calibre or entirely closed by contraction, the result of inflammation which had extended to it from the conjunctival sac. It is not possible to diagnose the presence of either of these conditions, which may be associated with stenosis or occlusion of the punctum lachrymale, except by the introduction of a very fine probe into the canaliculus. The passage may also be obstructed by an eyelash, a chalky deposit, or a mass of leptothrix.

Treatment. Where there is merely diminution in the calibre of the passage, the introduction of probes, increasing in size, is frequently enough to effect a cure. Dilators, on the same principle as Holt's instrument for the dilatation of urethral strictures, have been employed. If dilatation fail, recourse must be had to slitting up the canaliculus, but if it can possibly be avoided, that is, if a less extended opening will answer, the passage should not be slit up in its entire length. At least 3 mm. of its median end ought to be left intact, as otherwise regurgitation of tears from the lachrymal sac is liable to trouble the patient afterwards. If the canaliculus be completely closed by adhesions, so that a fine probe cannot be pushed through it, it becomes necessary to rip it up with the point of any small knife, following the known course of the passage from the outside. If the canaliculus be closed up to its opening into the sac, or if only at that

point, the obstruction must be pierced with the point of a fine knife. A great difficulty in all these cases is to keep the passage patent, when once formed. The only plan which affords tolerable certainty of this, is the frequent passage of probes into the sac, until the tendency to closure seems to have ceased; but even under favourable conditions recurrences of the closure are apt to occur.

Chronic Dacruocystitis, or **Blennorrhœa of the Lachrymal Sac** is caused by extension of inflammation from the mucous membrane of the nose, or from the conjunctiva, and is very frequently accompanied by blennorrhœa or stricture of the nasal duct, either of which conditions tend to aggravate the affection by causing retention of its secretions in the sac. Indeed, stricture of the nasal duct is probably a direct cause of dacruocystitis in a large number of cases. A mucous (mucocele) or mucopurulent discharge collecting in the sac gives rise to a swelling at its position near the inner canthus. This discharge frequently wells out through the puncta, or may be made to do so by pressure on the tumour, and its frequent presence in the conjunctival sac sets up conjunctivitis and blepharitis.

Spontaneous cure of a dacruocystitis is possible, so long as the walls of the sac are not greatly distended, but once this has taken place, surgical interference alone can relieve the affection.

Treatment. Any existing conjunctivitis or nasal catarrh should be treated. It is important to ascertain whether there be a stricture of the nasal duct, and for this purpose water should be injected by means of an Anel's syringe through the canaliculus into the duct. If

the fluid make its way freely into the nose or pharynx, it may be taken for granted that the nasal duct is not obstructed; while if, instead of passing through, or at least only under high pressure, it distends the lachrymal tumour to a greater size, a stricture may be assumed. If there be no stricture, the treatment consists in the very frequent pressing out of the contents of the sac by the patient, so that no distension of it may occur, and in this manœuvre he should endeavour to cause the discharge to pass down the nose rather than into the eye; while the surgeon, having, if necessary, dilated the canaliculus, injects astringent solutions (sulphate of zinc, nitrate of silver, alum, sulphate of copper) into the sac daily, to relieve the catarrh.

The caustic treatment, recommended further on for acute dacruocystitis, is often of the greatest benefit in these chronic cases.

If stricture of the nasal duct be present it must be relieved, or all other measures will prove futile.

Acute Dacruocystitis. Acute inflammation of the lachrymal sac most usually comes on when chronic dacruocystitis is already present. It is found with caries of the nasal bones, and may occur idiopathically, probably as the result of exposure to cold.

The region of the lachrymal sac and the surrounding integument become swollen, tense, and red, and these conditions spread to the lids, giving an appearance which may be readily mistaken for erysipelas; but the history of the case, showing the previous existence of lachrymal obstruction, &c., will assist the diagnosis. Gradually the point corresponding to the lachrymal sac

becomes the most prominent one of the swelling, and the abscess pointing there opens. When the pus has been discharged the inflammation subsides, and the opening through the skin may either close, the parts resuming their normal functions, or the opening may remain as a permanent fistula.

Treatment. In the early stages poultices and purgatives should be employed. As soon as palpation of the sac indicates the presence of pus it must be evacuated. This can be effected either through the canaliculus by opening it up to its entrance into the sac, or by an incision through the integument over the sac. The latter is the method I prefer, as it admits of free access to the interior of the sac. The day afterwards the walls of the sac are to be freely touched with solid mitigated nitrate of silver; or, a plug of cotton wool soaked in a strong solution of nitrate of silver may be inserted into its cavity and left there for some hours; or, various astringent solutions may be injected into the sac. The aim of the treatment, whatever it may be, is to secure a rapid return of the mucous membrane to its normal condition. If stricture of the nasal duct be present it must be treated *pari passu.* By these means the discharge from the sac is arrested, and the external opening closes up.

In cases of dacruocystitis, to reduce the tension in the sac Weber recommends the section of the internal palpebral ligament. This he does by passing his probe pointed knife through the upper canaliculus and as far as the upper end of the nasal duct, when, the edge of the knife being directed outwards, the ligament is divided by a lever motion of the instrument.

If a fistula should form, it may in many cases be induced to close by simply freeing an existing stricture of the nasal duct. Or, it may be necessary to pare its edges and bring them together by sutures. Or, especially if there be a long fistulous passage, the galvano-cautery, in the form of a platinum wire, may be applied with advantage.

Obliteration of the sac may have to be brought about in some very chronic cases where repeated attacks of acute inflammation and fistula occur, or where there is constant discharge and disease of bone, and when all other methods have failed to relieve the patient. This can best be effected by the application of a galvano-cautery to the lining membrane of the sac.

Stricture of the Nasal Duct is usually the result of swelling of its mucous membrane in catarrhal attacks, or of membraneous or cicatricial contraction resulting from long continued catarrh. It also occurs in consequence of disease of the bones of the nose, and from blows which fracture the bridge of the nose.

Treatment. Bony stricture may be regarded as incurable. Membraneous or cicatricial stricture is best treated by means of probes, in the manner proposed by Sir William Bowman.* The inferior canaliculus is slit up to a slight extent so as to admit the point of one of Bowman's smallest probes, which is given a curve to suit that of the nasal duct. With the fingers of the left hand the surgeon stretches the lower lid, and entering the probe into the canaliculus pushes it gently along its floor, until the point reaches the lachrymal bone forming the posterior

* *Ophthal. Hosp. Rep.*, October, 1857.

wall of the sac. The point being kept pressed against this bone, the direction of the probe is now altered by carrying it upwards towards the bridge of the nose, until it has arrived in the prolonged axis of the nasal duct, down which it is then pushed with a slow and gentle motion. Any obstacles met with on the way are overcome, if possible, by an increase of the pressure; but if at any part of the proceeding much difficulty be encountered, all further manipulation should be postponed to another day, rather than that any violence be used, and it is often found that at a second or third visit the probe is passed with comparative ease. Thicker probes are gradually introduced, until the largest size has been reached.

Otto Becker uses very fine probes, which he passes by the upper canaliculus. Weber's probes are conical, and of very large calibre at their thickest part. Their inventor passes them by the superior canaliculus, but many other surgeons pass them by the lower. I do not employ these probes, because, when passed into the nasal duct, their thickest part, which is 3-4 mm. in diameter, corresponds with the upper end of the duct, which is its narrowest part being only 3 mm. in diameter; consequently, the probe becomes more or less impacted at this place at each operation, and is apt ultimately to give rise there to hypertrophy of the periosteum, and finally to stricture, so that while the immediate effect of their use is good, the ultimate result is often the opposite. When used by the inferior canaliculus their size makes it necessary to slit that passage in its entire length, and the entrance of the passage into the sac must be enormously

dilated by so large an instrument, both of which circumstances are most undesirable.

Stilling* has proposed an operation, which he calls stricturotomy, for the cure of membraneous obstructions in the duct. Having slit up the canaliculus and ascertained with a probe the position of the stricture, Stilling passes his knife with the cutting edge directed forwards down the duct and through the stricture; he then withdraws it a little, turns the edge in another direction, and pushes it again through the stricture, and performs this manœuvre a third time before removing the knife. On subsequent days large probes are passed.

Dacruoadenitis, or **Inflammation of the Lachrymal Gland** occurs both in an acute and chronic form, but is extremely rare in either. I have seen one case of acute purulent dacruoadenitis, but no instance of the chronic affection. Swelling and hyperæmia over the gland and of the whole lid, with chemosis of the conjunctiva, and much local pain increased on pressure, are the most marked symptoms of acute dacruoadenitis. When suppuration has taken place, the abscess may open into the conjunctiva, as it did in my case, or through the skin. In the latter case it is liable to leave a fistula behind it, and indeed the chronic form may also, it is said, lead to fistula.

Treatment in the early stages consists in poultices and purgatives. When pus has formed, the abscess may be opened through the skin or from the conjunctiva.

Hypertrophy of the Lachrymal Gland is also of rare occurrence. It may attain such dimensions as to

* Heilung der Verengerung der Thränenwege. Cassel, 1868.

push the eyeball out of its position. It can only be dealt with by:—

Extirpation of the Lachrymal Gland. This operation has also been employed for cases in which no other method relieved persistent epiphora. It is performed by making an incision through the integument under the outer third of the orbital margin, the fascia under this is dissected up, the gland drawn out with a hook, and dissected out with a scalpel.

CHAPTER VIII.

DISEASES OF THE CORNEA.

PANNUS is treated of in connection with granular ophthalmia, which is its most usual cause, and phlyctenular corneitis is to be found under the head of phlyctenular ophthalmia.

Herpes Corneæ. Not only in herpes zoster ophthalmicus, but also in herpes febrilis a vesicular eruption is liable to occur on the cornea. Horner maintains * that herpes corneæ febrilis is a rather common affection, and is often not recognized by ophthalmologists he believes, because it usually first comes under notice when the secondary ulcers have formed. The following is Prof. Horner's description of the disease:—

On the surface of the cornea of one eye is formed a group of clear vesicles, each from 0·5 to 1·0 mm. in diameter, their appearance being accompanied by much tearing, but without any swelling of the eyelid. They usually form in a line which runs obliquely across the cornea, or sometimes in a vertical direction. Now and then they are arranged in trefoil shape, or in a circle. The covering of the vesicles is shortlived, and, as already remarked, the resulting ulcer is that which the surgeon

* Krankheiten des Auges im Kindesalter, p. 334.

usually first sees. Even it, however, is thoroughly characteristic. On the surface of the clear cornea is an irregular loss of epithelium, along the margins of which may still sometimes be seen the shreds of the late covering of the vesicle. The place bared of its epithelium displays regular contractions and dilatations, and can only be mistaken for a traumatic loss of epithelium. The latter, however, never presents the peculiar "string-of-beads" appearance. The floor of the loss of substance is formed by the superficial layers of the cornea, and the anæsthesia of the cornea is confined to this place—not so in herpes zoster. The tension of the eye is generally reduced. Under favourable circumstances this loss of epithelium may be rapidly repaired, although even then more slowly than one of equal dimensions but of traumatic origin. Usually the healing process is slow, more or less intense opacities forming in the area and at the margin of the ulcer, with hypopion, iritis, &c., the loss of substance becoming deep, with a dentated margin. This more unfavourable course is the result of secondary infection of the ulcer. The subjective sensations are relieved immediately after the bursting of the vesicles. The vesicular eruption is often regarded as irritation from a foreign body merely; or, occurring in the course of a serious disease (pneumonia, typhoid fever, intermittent fever, &c.) it passes wholly unnoticed, and its relationship to the latter unappreciated.

The derangements of the system in which herpes corneæ febrilis occurs, are naturally those in which herpes febrilis labii, nasi, &c., are found. These are especially the inflammatory affections of the respiratory tract, from

an acute catarrh of the Schneiderian mucous membrane to a severe pneumonia. On two occasions, with an interval of three years, Prof. Horner saw herpes corneæ occur in the course of an attack of pneumonia in a boy. In just such cases herpes on the lips, ala nasi, external ear, and eyelid of the same side are found; and in a case of double pneumonia in an adult occurred the only binocular herpes corneæ which Prof. Horner had seen. He explicitly states that he has seen herpes corneæ in connection with whooping cough, and often with intermittent and typhoid fevers.

Treatment, at an early stage, before the vesicles have burst, or the loss of substance has become infiltrated, consists in protection of the eye; and, when infiltration has set in, in disinfection with protection. If the vesicles give great pain, they may be ruptured by dusting a little calomel into the eye, or by brushing it with a camel's hair pencil wet with solution of boracic acid, and afterwards a well-fitting antiseptic bandage is applied. Atropine and warm fomentations should also be employed.

Absorption Ulcer is the term applied to a superficial ulceration, which is accompanied by but little opacity and by no vascularisation. It is usually seated at or near the centre of the cornea, where it presents the appearance of a shallow pit about 2 mm. broad with rounded margin. If the eye be exposed to cold wind or other irritation, some pericorneal injection makes its appearance and the eye tears, but these symptoms soon pass off again. The portions destroyed by the ulcerative process come away in the course of a few weeks, the surface begins to be covered with new epithelium, and reparation of the

corneal tissue commences. It takes months for this healing process to be completed, and often the defect is never quite filled up, but a small facet is left which is liable to interfere with vision.

The absorption ulcer does not tend to perforate nor to spread over the surface of the cornea.

It is not a common affection. It occurs chiefly in childhood, and probably indicates malnutrition of the general system; indeed, Sæmisch * thinks there is a close relationship between it and phlyctenular ophthalmia. I have seen it in granular ophthalmia without pannus.

Treatment consists in atropine and protection in the early stages, and the yellow precipitate ointment when the epithelium has become restored.

Deep Ulcer. In this there is much opacity of the floor of the ulcer and of the corneal tissue immediately around. Hypopion is often present, and a tendency to iritis and iridocyclitis exists. The pain is usually very severe, violent frontal neuralgia being a common symptom. The ulcer is generally round, but it may assume any shape, and may be situated in any part of the cornea. Its course may be slow or rapid. It has no great tendency to spread over the surface of the cornea, but has a very decided tendency to perforate through it. As the ulcer does not generally attain wide dimensions, the perforation it produces is apt to be small, and to give rise to a small adherent leucoma rather than to a staphyloma.

Causes. Abscess. Purulent conjunctivitis. Lodgment of foreign bodies, and other injuries of the cornea. And the deep ulcer may come on without any assignable cause.

* *Graefe und Sæmisch's Handbuch*, IV. p. 237

Treatment. If the ulcer be due to a conjunctival process, the latter should be actively treated, and only such remedies employed directly for the ulcer as will not act injuriously upon the conjunctiva. If the cause be other than conjunctival, a pressure bandage to give support to the ulcer is important, and periodical warm fomentations are most beneficial. Atropine should be instilled daily more than once. Eserine has been much employed of late as aiding in reduction of the intraocular tension and promoting the absorption of hypopion; but I do not use it, believing that the tendency to iritis is increased by it. Antiseptic applications, such as boracic acid, iodoform, and salicylic acid are useful, and may be dusted into the eye, or applied in ointments or solutions with the bandage.

Paracentesis of the anterior chamber through the floor of the ulcer is a proceeding always followed by improvement in the condition of the eye, and deserves a more routine application in these cases than is at present accorded to it, the more so as the little operation is simple and dangerless. But there are, I think, two imperative indications for its use, namely:—(1) Great pain. Very shortly after the operation, which for the moment increases the neuralgia, the patient experiences the greatest relief, and passes the first good night after many wakeful ones. (2) If perforation seem to be imminent. This may often be recognized by a bulging forwards of the thin floor of the ulcer, but sometimes it is not easily foreseen, and if there be any doubt on the point, paracentesis should be performed. It is important to forestal spontaneous perforation of the ulcer by this proceeding, because the open-

ing made by the latter being linear heals easily, and leaves but a slight scar without anterior synechia; while the natural opening would be a complete loss of substance, and therefore the more readily involve adhesion of the iris in the resulting comparatively extensive cicatrix.

The use of the actual cautery in these cases has not yet had a sufficient trial to enable us to speak positively of its advantages or the contrary.

Ulcus Serpens (also known as Sæmisch's Ulcer). This is characterised by its tendency to extend over the surface of the cornea, especially in some one direction, as well as to strike deep into its tissue. Its position is chiefly central, and it presents a greyish floor, which is more intensely opaque at some places. One part of the margin takes the form of a curve, or of several closely placed curves, and here becomes yellowish-white in colour and somewhat raised, and the floor of the ulcer seems deeper in its neighbourhood. Immediately around the ulcer the cornea is slightly opaque, but further out it is quite normal. The degree of pain and irritation varies much, being almost absent in some cases, while in others it is extremely intense. Iritis is apt to come on at an early period, and may pass into irido-cyclitis. Hypopion is almost always present. The ulcer creeps over the surface of the cornea in the direction of the curved and intensely infiltrated margin, and in other directions it may begin to cicatrize. At a still later stage the whole cornea is apt to become infiltrated, and the entire margin of the ulcer to extend, and the anterior chamber becomes quite full of pus. Perforation now takes place, or may do so somewhat earlier. If the perforation be small, an adherent

leucoma results, but if large a staphyloma is produced.

Causes. Ulcus Serpens usually has its origin in a trauma which produces, it may be, only a slight abraision of the epithelium. In a large percentage of the cases chronic dacruocystitis is present, and a large proportion of the cases occur in the agricultural population, especially in harvest time. The investigations of Leber* and others make it probable that a fungus (aspergillus) obtaining entrance through the loss of epithelium sets up this peculiar ulcerative process. This fungus is probably present in the secretion of the lachrymal sac, or floats in the air during the oats, barley, and wheat harvest.

From the above description it will be seen, that the process is a very severe one in many instances, and the prognosis bad.

Treatment. If the case be not severe, atropine with protection of the eye may cure in a few days. Here, too, some surgeons prescribe eserine. Warm fomentations are useful, and a pressure bandage, provided there be no dacruocystitis. Antiseptic measures should always be employed, iodoform being the application most likely to prove of use. It may be employed either in the form of a strong ointment (gr. xxx ad ℥i) put into the eye, or it may be dusted on the floor of the ulcer with a camel's hair pencil. Scraping the floor of the ulcer with a sharp spoon has also been suggested.

Sæmisch's Method† is intended to be adopted when milder measures are found powerless to arrest the pro-

* *V. Graefe's Archiv*, XXV. part ii. p. 285.

† *Graefe und Sæmisch's Handbuch der Augenheilkunde*, IV. p. 254.

gress of the ulcer. It consists in division of the ulcer with a Graefe's cataract knife. The point of the instrument is entered about 2 mm. from the margin of the ulcer in the healthy corneal tissue, and being passed through the anterior chamber behind the ulcer the counter puncture is made in the healthy cornea some 2 mm. from the opposite margin of the ulcer. The edge of the knife being then turned forwards the section is slowly completed. The incision should divide the intensely infiltrated part of the margin in half. The aqueous humour and hypopion are evacuated, and a bandage having been applied, the patient soon gets relief from pain. Every day, until healing is well established, the wound must be opened up from end to end with the point of a fine probe, the contents of the anterior chamber being thoroughly evacuated on each occasion. The result is that, in a vast majority of cases, the progress of the ulcer is arrested, and healing soon sets in. The little operation should not be delayed long, but it may be employed with advantage even in late stages of the process.

The Actual Cautery has of late been supplanting Sæmisch's operation in the hands of some ophthalmologists. Various forms of cauteries have been employed, but the galvano-cautery is the most suitable, and especially the instrument (Fig. 67) devised by Professor Sattler of Erlangen. A medium-sized bichromate of potash bottle battery is attached to the instrument, and the platinum wire brought to a red heat. The infiltrated and undermined margin of the ulcer is the part which should be most thoroughly cauterized, but the floor of the ulcer, if much infiltrated, may also be dealt with. If

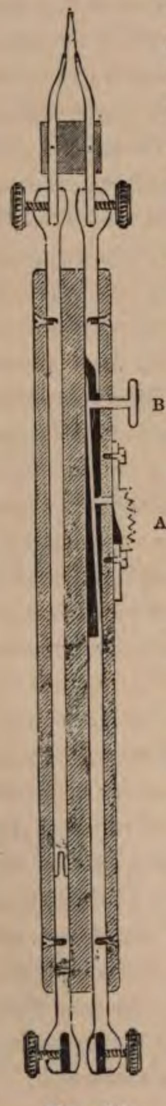


FIG. 67.

necessary, the cauterization may be repeated on the following day, and even for several days in succession. I have myself had satisfactory results from this method, which seems a rational one from the point of view of Leber's theory.

Diffuse Interstitial Corneitis. This affection occurs chiefly between the ages of five and fifteen. It commences at one part of the margin as a light greyish opacity, accompanied with slight injection of the marginal vessels. The rest of the corneal margin soon becomes similarly affected, and then gradually the opacity extends concentrically into the cornea, or does so by sending in processes which afterwards become confluent. In this way the whole cornea becomes affected by degrees, and looks as if breathed on, an appearance which is seen also in acute glaucoma. The opacity is here and there slightly more intense, and may be seen to lie in the substance of the true cornea. When the whole membrane has become opaque, the margin begins to clear up, and the central portion becomes even more opaque than the margin had ever been, a fact which

The bolt A. being pushed forwards the current is completed, and passes through the platinum wire which forms the cautery. By pressure on the button B. the current can be momentarily intercepted during use of the instrument.

shows that the very cells which entered the cornea at its margin have advanced to its centre. The clear margin gradually increases in width, until only a rather intense central opacity is left. This latter slowly breaks up and becomes absorbed, but not always completely, and consequent permanent impairment of vision may remain.

There is no tendency to ulceration in this affection. The process may run its entire course without any vascularisation of the cornea; or, a few vessels may be found here and there in the deep layers; or, again, a very intense vascularisation may gradually occupy the whole cornea, following the progress of the opacity. The greater the vascularisation the quicker the process, and the more complete is the clearing up likely to be.

The affection is generally accompanied with a good deal of pain and blepharospasm. It is very liable to be complicated with iritis and even iridocyclitis, and herein lies its chief danger. The iritis is usually of the serous form, but may be plastic, and opacities in the vitreous humour often result from it. Exudative choroiditis and optic neuritis may also complicate it.

The acute stage of the disease lasts six to eight weeks, or longer, and the entire process may not be completed in the course of many months. Both eyes are almost invariably affected, although rarely at the same time, the second eye not becoming attacked until the inflammation in the first has made some progress, and often not until it has undergone cure. It is important to acquaint the patient with the likelihood of this in the very commencement of his treatment. Horner has seen the corneal affection recur, but I have not been so unfortunate.

In view of the serious complications liable to supervene, and which may completely annihilate vision, and of the possibility of an incomplete clearing of the cornea, and the irregularity of its surface which the process may cause, the prognosis must be guarded.

Causes. The affection is more common in girls than in boys, and most frequently appears during second dentition, when the upper incisors are being cut, or at puberty. It depends upon some serious disturbance of the general nutrition, and this, in over 50 per cent. of the cases, is inherited syphilis, a fact first pointed out by Mr. Jonathan Hutchinson.* The children are generally thin, anæmic, and of stunted growth, with flat nose and cicatrices at the angles of the mouth, and the peculiarities of the incisor teeth, so well known from Mr. Hutchinson's description, are present in about one half the cases.

Treatment. In the early stages no irritants should be locally applied. Atropine is important for the prevention of iritis, or of posterior synechiæ; and the use of warm moisture in the form of poultices or fomentations promotes vascularisation, and hastens absorption of the cellular elements which form the opacity. When the acute stage is ended, the yellow precipitate ointment may be employed with benefit, for stimulating the absorbents to carry off the remains of the opacity. Peritomy sometimes arrests the further progress of the opacity if performed in an early stage (Horner). The constitutional treatment may consist, according to some authorities, in

* Diseases of the Eye and Ear consequent on Inherited Syphilis. London, 1863.

a mercurial course; but others, and I rank myself amongst them, prefer a tonic plan from the commencement, or at most would employ iodide of potassium. Iodide of iron, and cod-liver oil, are the best internal remedies in this disease.

Counter-irritation in the form of blisters to the temple, or a seton in the scalp, is extensively employed by some surgeons. I have never adopted this treatment, as I doubt its value, and am loath to add a worry to the troubles inseparable from so wearisome a disease.

Sclerotising Opacity of the cornea complicates scleritis, affecting the cornea in the neighbourhood of the scleral affection, and not extending more than 2 to 3 mm. into the cornea, except in very severe cases. It is a very intense white opacity, but is capable of almost quite disappearing again along with the scleritis.

Treatment is that for the scleritis (p. 191).

Abscess. This is seen as a yellowish circumscribed opacity, surrounded by a slight grey zone. It is usually round in shape, but when near the margin it is apt to be crescentic. Abscess differs from infiltration, inasmuch as it destroys the fibrillæ and fixed corpuscles. Hypopion usually accompanies a corneal abscess, and there is frontal neuralgia and photophobia, especially in the beginning. Iritis, cyclitis, and even choroiditis may supervene.

Abscess rarely bursts inwards, but generally the superficial corneal layers covering it become uneven, more prominent, and finally fall in, and in this way an ulcer is formed. Although the abscess rarely bursts inwards, yet the hypopion is believed to be derived directly from it, by

permeation of the pus through the posterior layers of the cornea.

If the abscess be small, and come under treatment at an early stage, it may become absorbed and complete cure result. If the abscess be large, ulceration can hardly be prevented, and the ulcer which is produced is the Deep Ulcer already described.

The causes of corneal abscess are:—injuries, blennorrhœa, of the conjunctiva, and diseases such as typhus or typhoid fever and smallpox. It also occurs without any assignable cause.

Treatment in the early stage must depend upon the cause of the abscess. If this be a conjunctival blennorrhœa, then the latter must be actively treated, and no measures employed which would interfere with its progress. Warm fomentations and the bandage are therefore contra-indicated, but atropine should be employed. If the cause be other than conjunctival, warm fomentations, a pressure bandage, and atropine should all be used. Some have adopted incision, but this has not found general favour. When once ulceration has taken place the treatment is that of the Deep Ulcer.

Neuroparalytic Corneitis. In paralysis of the Ophthalmic Division of the Fifth Nerve, purulent infiltration and ulceration of the cornea is often observed. It was formerly believed that the fifth nerve had an influence over the nutrition of the cornea, and hence that this was a trophic process; but experiment has shown that this is not the case, and that the affection is merely due to the loss of sensation, which renders it

possible for foreign substances to remain on the cornea unremoved by a reflex motion of the lid.

Treatment consists in protection of the cornea by a bandage on the eye, or by keeping the lids fastened together with an epidermic suture.

Infantile Ulceration of the Cornea, first described by von Graefe,* is a very rare affection, of which a few cases came under my notice at von Graefe's clinique. Recent investigations by Leber show that it is due to the invasion of the cornea by a parasitic growth (micrococci and bacilli), and not, as at one time supposed, to an encephalitis producing defective nutrition.

Ribandlike Corneitis. (Transverse Calcareous Film of the Cornea. Calcareous Film of the Cornea.) This is an alteration which occurs chiefly in the corneæ of eyes destroyed by severe intraocular processes, such as iridocylitis, sympathetic ophthalmitis, glaucoma, etc. It occupies that transverse strip of the cornea which is uncovered in the commissure of the eyelids during waking. It usually commences on the inner margin of the cornea, but soon appears at the outer margin, and advances from each direction towards the centre, where the two sections join. It presents the appearance of a greyish brown opacity, with, in many but not all cases, white calcareous deposits in and under the epithelium. Magnus † points out that in blind eyes which are constantly rolled upwards, the opacity is found not in the central transverse section of the cornea, but in its lower third, and from this fact argues that the chief

* A. v. *Graefe's Archiv*, Vol. XXIX. part iii. p. 225.

† *Klin. Monatsbl. f. Augenheilkunde*, February, 1883, p. 45.

factor for its production is exposure of the part. And he believes, moreover, that so large a proportion of the affected eyes having suffered severely in their general nutrition, indicates the opacity to be a further development of this malnutrition. He proposes for the affection the name Keratitis trophica.

Staphyloma Corneæ, is the result of a perforating ulcer of the cornea. The latter having healed may present a weak cicatrix, which becomes bulged forwards by the normal intraocular tension (Figs. 68 and 69.) If

FIG. 68. (*Pagenstecher.*)

FIG. 69. (*Pagenstecher.*)

the iris be not involved in this cicatrix the anterior chamber will be made deeper (Fig. 69).

Staphyloma corneæ, in which the iris is involved, is probably a more common condition than the above.

When the ulcer is large, a correspondingly large portion of iris is liable to become prolapsed into it, and to form a bulging mass outside the eye. This may burst and collapse, and a flat cicatrix may be formed. Or, if it do not rupture, it may form what is termed a partial staphyloma of the cornea and iris, the latter becoming consolidated by the formation of a layer of connective tissue over it.

If the whole, or a very large part of the cornea be destroyed by an ulcer, the iris is completely exposed. It soon begins to be covered with a layer of lymph, which developes into an opaque cicatricial membrane. If this be not strong, the normal intraocular tension is sufficient after a time to make it bulge; or, increased intraocular tension may arise, owing to further changes within the eye, and then bulging of the pseudo-cornea comes on, and the condition is termed total staphyloma of the cornea. Sometimes a total staphyloma has a lobulated appearance, owing to the pseudo-cornea having some fibres stronger than others.

Treatment. In cases of partial staphyloma, where a clear portion of the cornea remains, an iridectomy is frequently indicated for the reduction of the tension, as well as for the sake of an artificial pupil, which may improve sight when the normal pupil is obliterated by corneal opacity. When, sight having been lost, the staphyloma is very bulging, or when total staphyloma is present, one of the following operative measures must be adopted.

Incision. With a cataract knife, the edge directed forwards, the staphyloma is transfixed at its base, and the instrument made to cut outwards through the summit of the staphyloma. Portion of the contents of the eyeball (aqueous humour, lens, and some of the vitreous humour) are evacuated; and, the staphyloma collapsing, a flat cicatrix is formed.

Abscision. A Beer's cataract knife being passed through the base of the staphyloma, with its edge directed upwards, the upper two-thirds of the staphyloma are separated off, while the remaining third is detached by

means of a scissors. If the lens be present it must now be removed. The wide opening becomes filled up with granulations and cicatrises over.

De Wecker * closes the opening with conjunctival sutures. He begins the operation by separating the conjunctiva all round the margin of the cornea and loosening it from the eyeball nearly as far back as its equator. Four sutures (*a. b. c. d.*) of different colours are then passed through the conjunctiva about 2 to 3 mm. from the margin of the wound, as represented in Fig. 70. In order to keep the field of operation clear, the ends of

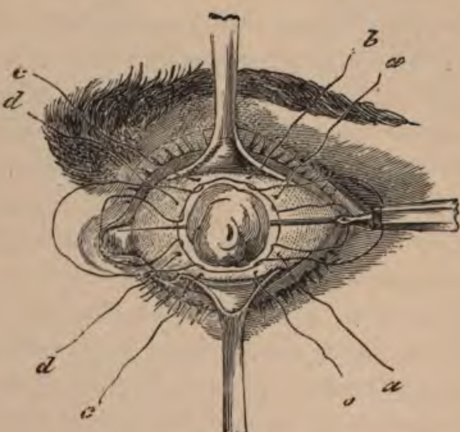


FIG. 70. (*de Wecker.*)

two of these sutures are laid over on the nose, while the others are laid over on the temple. The staphyloma is now abscised and the sutures drawn together and tied. The conjunctival scar can be tatooed in the centre

* Chirurgie Oculaire, p. 188.

at a later period, and by this means the wearing of an artificial eye made unnecessary.

G. Critchett proposed the following method, which has met with much approval. The base of the staphyloma is transfixed with four or five curved needles passed from above downwards at regular intervals (Fig. 71),

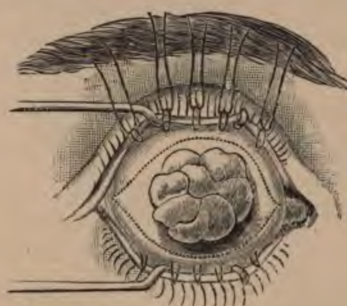


FIG. 71. (*Abadie.*)

the punctures and counterpunctures being in the sclerotic, at points half way between the margin of the staphyloma and the insertion of the recti muscles. With a sharp knife the staphyloma is now divided horizontally, the incision running from the insertion of the external rectus to that of the internal rectus; and then the two halves of the staphyloma are abscised with scissors, the line of abscision lying some 2 mm. from the points of entrance and exit of the needles. The latter are now drawn through and the sutures tied, so that the edges of the sclerotic may be applied to each other as accurately as possible. The resulting stump (Fig. 72) is capable of carrying an artificial eye without becoming irritated.

The foregoing, and other methods of abscision, are

only applicable where the tension is either low or normal. If it be high, the liability to intraocular hæmorrhage during the operation makes enucleation a much more suitable proceeding.

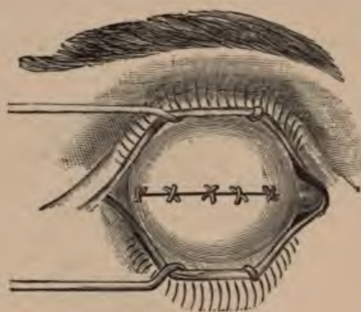


FIG. 72.

Conical Cornea. In this the cornea is altered in shape to that of a cone. The change is due to an atrophic process in the cornea, especially at its centre, in consequence of which the normal intraocular tension acts on it, so as to distort it into the form represented in Fig. 73. The cornea remains clear, except sometimes just at the apex of the cone, where a slight nebula may be present. The condition is easy of diagnosis in its advanced stages, but in its commencement may not be so. The light reflected from the ophthalmoscope on the cornea gives rise to reflexions, of which the shape is characteristic.

FIG. 73.

The process progresses slowly, but never leads to rupture of the cornea. Both eyes are apt to become attacked

one after the other, and spontaneous cure does not take place. The disturbance of vision is very great, owing to the extreme irregular astigmatism produced.

Treatment. Glasses (spherical, cylindrical, or hyperbolic), and stenopæic apparatus are usually of little value, but should be experimented with in each case.

Steinheim* reports a case, in which the keratoconus was much reduced, and V. greatly bettered, by instillations of eserine and the application of a pressure bandage continued for several months.

Von Graefe's is the best operative method hitherto proposed. It consists in flattening the cornea by the production of an ulcer on the apex of the cone and the resulting cicatricial contraction. From the surface of the cornea, a little to one side of the apex of the cone, a morsel of corneal substance is removed with a cataract knife, care being taken not to open the anterior chamber. On the second day after this proceeding the wound is touched with mitigated lapis (solid), and this is repeated every third day for a fortnight or three weeks. Paracentesis of the anterior chamber is then performed through the floor of the ulcer, and the aqueous humour evacuated every second day for a week, after which the healing process is allowed to take its course. A bandage must be worn during the whole course of the treatment. Finally, when the contraction and consequent flattening is completed, a narrow iridectomy may be necessary, in consequence of the central, or almost central, and rather intense corneal opacity.

Tumours of the Cornea. Epithelioma has occasion-

* *Arch. of Ophth.* Vol. IX. No. 2, p. 192.

ally been found starting from the corneal margin. Dermoid growths are seen on the margin of the cornea, extending over to the conjunctiva. They are described in connection with diseases of that mucous membrane.

Injuries of the Cornea. The most common injuries are those caused by small foreign bodies (particles of metal, stone, &c.), which fly into the eye, and which may either cause a mere superficial loss of substance, or may stick in the cornea. In the former case the application of a protection bandage will enable the epithelium to be completely regenerated in a day or two.

A foreign body in the cornea is a serious matter, in proportion to the depth to which it has penetrated. Very superficial foreign bodies are easily removed, and leave no scar.

In removing a foreign body from the cornea, when the patient can control himself to some extent, the surgeon need use no instrumental fixation of the eye. The patient being seated, leans his head against the surgeon's chest, who stands behind. The latter, with the index finger of the left hand, raises the upper lid of the injured eye, pressing the margin upwards and backwards, while with the second finger he depresses the lower lid in a similar manner, and between these two fingers he can to a great extent restrain the motions of the eyeball. The foreign body is now to be pricked out of the cornea with a special needle, without more injury of the general surface than can be avoided, the patient directing his gaze steadily at some given point. If the foreign body be deep in the layers of the cornea it must be dug out, as it were, and a minute gouge is made for this purpose. Should

the patient be quite unable to control himself, it becomes necessary to use the spring elevator and fixation forceps. A bandage is applied until the epithelium is regenerated.

Simple incised wounds of the cornea, without prolapse of the iris, heal rapidly by the first intention, leaving but slight scar. If prolapse of the iris have occurred, and the case be seen sufficiently early, attempts should be made to repose the prolapse with a spatula, or to induce retraction of it into the anterior chamber by use of eserine or atropine, or of each in turn. If all these attempts fail, the prolapse should be abscised carefully on a level with the corneal surface.

Arcus Senilis. This is a change which is developed in the cornea without previous inflammation. It presents the appearance of a greyish line near the margin of the cornea and all round it, most marked above and below, and never advancing further towards its centre. It is most common in elderly people, but is sometimes seen in youth, and even in childhood. No functional changes are caused by it, nor does it interfere with the healing of a wound which may be made in that part of the cornea. Arcus senilis is caused by fatty degeneration of the corneal cells and fibrillæ.

Nebula. Macula. Leucoma. These terms are applied to opacities in the cornea, of varying degrees, the result of some diseased process, or consequent upon an injury. The first term is used for very slight opacities, often discoverable only with oblique illumination. Macula indicates a more intense opacity, recognisable by daylight. Leucoma is a completely non-translucent and intensely white opacity, the result always of an ulcer, which has

destroyed most of the true corneal tissue at the affected place; indeed, it is often the result of an ulcer which has eaten its way through the cornea. In these latter cases the iris may have become adherent in the corneal cicatrix, and then the term leucoma adhærens is employed.

Treatment. Little or nothing can be done to reduce these opacities. In slight and fresh cases, massage often renders them less intense.

For leucoma the operation of tatooing has been proposed by de Wecker, and is a valuable proceeding for improvement of the appearance of the eye. Either the whole surface of the leucoma may be tatooed or only part of it, *e.g.*, its centre, in order to represent a pupil. The material used is fine Indian ink, rubbed into a thin paste. The leucoma is spread with this, and then covered with innumerable punctures by means of de Wecker's multiple tatooing needle, each stab of which carries into the corneal tissue some of the black pigment. The operation, except for the fixation, &c., of the eye, is not painful, as the nerves in the cicatrix have been destroyed.

CHAPTER IX.

DISEASES OF THE SCLEROTIC.

Scleritis appears in the form of a rather circumscribed purplish spot close to, or 2 to 3 mm. removed from the corneal margin. It is often unattended by pain, unless when the eye is exposed to irritating causes, and need not be elevated above the level of the sclerotic; but in very severe cases there is decided swelling at the affected place, with pain, more or less pronounced, while the cornea in the immediate neighbourhood is apt to become opaque to a marked degree (sclerotising opacity). All these appearances are capable of going back, and may reappear at an adjoining place, and so in time the whole circumference of the sclerotic may have been attacked. The duration of this affection is always long, and in those instances where the entire sclerotic becomes affected by degrees, the process may last two or three years.

Severe cases become complicated with iritis and choroiditis, and then come under the denomination of anterior sclero-choroiditis.

Causes. The affection is often found to be of rheumatic origin, it occurs sometimes in persons of scrofulous or syphilitic constitution, and is more frequent in women than in men.

Treatment. No irritant should be applied to the eye.

Local treatment should be confined to warm fomentations, protection, and atropine to avert iritis. In addition to these massage* should be used, if there be not too great tenderness on pressure. Leeching at the external canthus is sometimes of use. As regards internal remedies, where a syphilitic taint is present, mercury should be employed; if struma, cod-liver oil, maltine, etc.; or if, as is most frequently the case, a rheumatic taint be the source of the evil, large doses of salicylicate of sodium, say 20 grains every fourth hour, will often be found to act well. Iodide of potassium and hypodermic injections of pilocarpine are useful remedies in some cases of this obstinate disease.

Injuries of the Sclerotic. Simple incised wounds heal without difficulty. Those which are complicated with prolapse of the choroid and vitreous body are apt to be attended with intraocular hæmorrhage, detachment of the retina, or violent intraocular inflammation.

A danger of a simple incised sclerotic wound, even

* Massage was introduced into ophthalmic therapeutics by H. Pagenstecher of Wiesbaden (*Centralb. f. Augenhk.* Dec. 1878). Pressure is made against the edge of the upper or lower eyelid, as the case may be, with the thumb or forefinger, and the eyelid is rubbed as rapidly as possible to and fro over the eyeball, in a radiating or circular direction. The rubbing should be done without pressing heavily on the globe; the finger flying over the eye. Some yellow precipitate ointment may be previously inserted into the conjunctival sac. The effect of the measure depends probably upon the complete evacuation for a time of the blood and lymph vessels around the sclerocorneal margin and in the cornea, by which they afterwards gain greater capacity for absorbing exudations which may be present. After massage the intraocular tension is often reduced for a while. Chronic affections of the cornea and sclerotic are those for which the proceeding has proved most useful.

though healing take place rapidly, is, that long afterwards, as a result of the cicatrisation, a change in the relation of the retina to the choroid and sclerotic may be produced, with consequent detachment of the retina.

Rupture of the Sclerotic often occurs from blows on the eye, the most usual situation being the immediate neighbourhood of the cornea. Prolapse of the iris and ciliary body, and evacuation of the lens and of portion of the vitreous, often accompany these injuries, and involve loss of the eye, while, if cyclitis be set up, danger to the other eye by sympathetic ophthalmitis may arise.

CHAPTER X.

DISEASES OF THE IRIS.

Iritis. The most rational division of the different kinds of iritis is that founded on their pathology, namely:—1. *Simple Plastic Iritis*; 2. *Serous Iritis*, and 3. *Parenchymatous* (including *purulent*) *Iritis.*

Their *Common Characteristics*, more or less marked, are: —Irritability of the eye and pericorneal vascular injection, with loss of lustre, discolouration, and functional disturbances (impaired mobility) of the iris.

Exudation of inflammatory products is present in greater or less degree in all these forms, and is found:— 1. On either surface of the iris and in the pupil, in plastic iritis. 2. In the aqueous humour and posterior surface of the cornea, in serous iritis. 3. In the tissue of the iris, in parenchymatous iritis.

Posterior synechiæ, *i.e.*, adhesions between the iris and the anterior surface of the lens, occur as the result of inflammatory exudation on the posterior surface or pupillary margin of the iris. The presence of posterior synechiæ is ascertained by observing the motion of the pupil when the eye is placed alternately in strong light and in deep shadow; or, by observing the effect of a drop of atropine solution on the pupil, when the latter

will dilate only at those places where there are no synechiæ. If the entire pupillary margin have become adherent, the condition is termed complete posterior synechia, circular posterior synechia, or ring synechia; and in such cases, if of some standing, atropine has no effect on the pupil. If the area of the pupil be filled with exudation, circular synechiæ being usually also present, the condition is known as occlusion of the pupil.

Simple Plastic Iritis is the most common form. In it the pericorneal injection is generally well marked, sometimes causing elevation of the limbus of the conjunctiva, and even general, although slight chemosis. In very mild cases, however, as also in chronic cases, the injection may be slight. The loss of lustre of the iris is well marked, owing to disorganization of the epithelium covering its anterior surface, and clouding of the aqueous humour. For the same reasons there is considerable change in colour of the iris. In some cases of plastic iritis an enormous quantity of gelatinous exudation is present in the anterior chamber. Posterior synechiæ are very liable to form.

In Secondary Syphilis one often sees iritis, which, although doubtless due to the syphilitic taint, presents no characteristic different from ordinary simple plastic iritis.

Rheumatic Iritis is of the simple plastic form, but accompanied by pericorneal injection, which is great in proportion to the other signs of iritis present.

Gonorrhœal Iritis is a mixture of the plastic and serous forms. It does not attend on, nor immediately follow a gonorrhœa, but an attack of rheumatic arthritis, usually

of the knees, always intervenes. Gonorrhœal iritis is extremely rare.

Serous Iritis. Here the exudation is mainly a serous fluid. From this fluid fibrinous elements in the form of very fine yellowish spots are precipitated on the posterior surface of the cornea, chiefly in its lower quadrant and often in a triangular shape, the base of the triangle corresponding with the lower margin of the cornea, the apex being directed towards the centre of the cornea. In cases where the corneal deposit continues for a length of time, permanent secondary changes in the true cornea are produced, and a consequent peculiar triangular opacity at the lower part of the cornea will ever afterwards indicate the nature of the process which has gone before.

In serous iritis the anterior chamber is often deep, owing to the quantity of fluid secreted, and the aqueous humour is opaque. The increase in the contents of the anterior chamber frequently causes increase in the intra-ocular tension. The pupil, as in glaucoma, is apt to be dilated, and the pericorneal injection and general irritability of the eye may be but slight. Pure serous iritis is perhaps not so common as a mixed form of sero-plastic iritis.

Parenchymatous (or **Purulent**) **Iritis.** Here the inflammatory product is situated in the tissue of the iris. The consequent swelling of the iris may be present over its whole extent, or may be confined to a circumscribed part of it. In the latter case the swelling is sometimes called a condyloma, tubercle, or gumma. The colour of the iris changes remarkably at the affected part to a

yellowish or reddish-yellow hue, and new vessels are formed in it.

Parenchymatous iritis is more dangerous to the integrity of the iris tissue than either of the other forms.

In Syphilis, when the disease is passing from the secondary to the tertiary stage (de Wecker), a form of iritis occurs, which may be always recognised as syphilitic. It is characterised by the formation of circumscribed tumours, or small gummata of a pale yellowish colour, the rest of the iris being intact. These tumours vary in size from that of a hempseed to that of a small pea, and are situated usually at the pupillary margin, occasionally at the periphery of the iris, and very rarely in the body of the iris. There may be but one tumour present, and there are seldom more than three or four. This form belongs to the parenchymatous class, and is by no means common.

Symptoms of Iritis in General. 1. Pain. This is situated not so much in the eye as in the brow over it, in the corresponding side of the nose, and in the malar bone, and may even extend to the whole side of the head. It varies in its intensity, and is usually more severe at night. The simple plastic form is the one attended with the most severe pain, the serous form is generally unattended with pain, while the parenchymatous form is often excessively painful, and again completely painless. 2. Tearing and photophobia are occasionally present, but never to such a degree as is often observed in certain corneal affections. 3. Dimness of vision. This is usually complained of as soon as the inflammation is pronounced, and is in general more marked the more the form ap-

proaches that of serous iritis, *i.e.*, the more the posterior surface of the cornea is covered with fibrinous deposit, and the more cloudy the aqueous humour is. Exudation in the pupil may reduce vision to a quantitative amount.

Prognosis. The duration of an attack of iritis is from two to eight weeks, the plastic form being the most rapid and the serous form the slowest. Recurrences of the inflammation are common, partly as the result of irritation from dragging in the motions of the iris at points where posterior synechiæ are situated, and partly owing to the constitutional taint which may have given rise to the iritis in the first instance.

It is possible that any form of iritis, if carefully treated from the beginning, may leave the eye in as healthy a condition as before; but it is a more common result, in spite of every effort, for posterior synechiæ, isolated or as a circular synechia, to be left behind. If the adhesions be isolated, and relapses occur from irritation set up by dragging on them, fresh adhesions may be formed, until ultimately a complete posterior synechia is established. When this takes place, the aqueous humour being still secreted behind the iris, the latter becomes bulged forwards like the sail of a ship, until it touches the peripheral part of the cornea, while the centre of the anterior chamber retains its normal depth. This condition is very liable to induce glaucomatous tension (secondary glaucoma) and consequent loss of vision; or, if the eye escape this danger, the traction on the ciliary body produced by the tensely stretched iris may develope chronic inflammation of the ciliary body and choroid, so

called chronic irido-cyclitis, or irido-choroiditis; and this may lead to diminished tension and phthisis bulbi, with detachment of the retina and calcification of the lens. Or, the eye having been first blinded by high tension, may at a later period undergo phthisis bulbi.

Causes.—Iritis is not common in children, except as complicating a corneal process, or as a result of congenital syphilis. Towards puberty slight plastic iritis is sometimes found in girls. Youth and middle age are the times of life in which iritis is most often seen, in old age it again becomes rare. More than 50 per cent. of the cases depend on syphilis, and a large proportion of the remainder are due to rheumatism. During desquamation after smallpox plastic iritis is sometimes observed. In metria and septicæmia purulent iritis occurs, as also with typhoid fever, pneumonia, and recurrent fever.

Treatment.—Atropine is above every other means the most important. It is used in solution (Atrop. sulph. gr. iv, Aq. dest. ℥i) as drops.* By paralysing the sphincter iridis it provides rest for the inflamed iris; and if adhesions have already formed, the dilatation of the pupil may break them down, while if none are as yet present, the dilatation will greatly aid in preventing their formation. It also acts as a local anæsthetic. To produce a maximum effect, where it is desired to break down adhesions, six drops should be instilled into the eye with an interval of from five to ten minutes between each; and in this way every drop has time to make its way into the

* Also in the form of ointment, Atrop. sulph. gr. 4, Vaselin ad ℥i. A little of which is put into the conjunctival sac.

anterior chamber, and finally the accumulated effect of all six is obtained. More than one drop can hardly be retained in the conjunctival sac at a time. The usual run of cases of iritis require a drop in the eye from twice to four times a day.

Some individuals are peculiarly susceptible of atropine poisoning, of which the symptoms are:—dryness of the throat, fever, fulness in the head, headache, delirium, coma. The antidote is morphium, of which $\frac{1}{4}$ grain used hypodermically neutralizes $\frac{1}{30}$ grain of atropine in the system, according to Leeser.* Atropine poisoning occurs by reason of introduction of the solution into the stomach through the lachrymal canaliculi and the nose and fauces; and, in order to prevent this, the finger (of the patient) may be placed in the inner canthus so as to occlude both canaliculi during and for some moments after the introduction of the drop into eye. After long use of atropine the skin of the lower eyelid often becomes red, swollen, and painful, and in other cases follicular conjunctivitis is induced. If these occur, sol. extr. belladonna (gr. viii ad ʒi) should be substituted for atropine. In old people tenesmus and retention of urine sometimes result from use of atropine.

In addition to the instillation of atropine, the patient in severe cases of iritis should be confined to a dark room, and even to bed.

In Simple Plastic Iritis iodide of potassium or perchloride of mercury may be given internally. If there be much irritation, pericorneal injection, or chemosis, leeching at the external canthus is of use. Intermittent warm

* Die Pupillarbewegung, &c., p. 75.

fomentations (every two hours) promote healthy vascular reaction. Pain is to be relieved by hypodermic injections of morphium and chloral internally.

In rheumatic iritis salicylicate of sodium in large doses (20 to 30 grains every three hours) has often a remarkably favourable effect.

In Serous Iritis a small quantity of atropine will suffice, as there is little tendency to the formation of synechiæ; and, the irritation being slight, leeching is unnecessary. The skin (pilocarpine hypodermically, Turkish baths, and dry rubbing), kidneys, and bowels should be acted on, and to the diuretics prescribed some iodide of potassium may be added. Blistering on the temples is with many surgeons a favourite remedy. It adds to the annoyance of the patient, but I have no belief in it as a remedy in this, or, indeed, in any other eye disease. Great care is required in watching the state of the tension in this form of iritis, and, if it be found to increase, paracentesis of the interior chamber must be performed to reduce it temporarily while the iritis is progressing towards cure. This little operation will also be called for if there be much deposit on the posterior surface of the cornea, as by means of it the deposit, to a great extent, may be floated away.

In Parenchymatous Iritis it is important to get rapid absorption of the inflammatory products so abundantly thrown out, and which, in an organ like the eye, would soon cause extensive destruction. Consequently, the system should be put under the influence of mercury as quickly as possible by the use of inunctions of mercurial ointment, or by small doses of calomel internally, and this

treatment is indicated even when the inflammation is not of syphilitic origin. Warm fomentations are useful. An after treatment with iodide of potassium is to be employed.

In syphilitic iritis of the plastic form v. Graefe was fond of the following formula :—

℞ Hydrag. biniodid. gr. vi.
Potass. iodidi, ʒ i ss.
Aq. destill. ℥ ss.
Syr. Aurant. ℥ ii ss. M.

A teaspoonful to be taken once a day. The dose to be gradually increased.

Injuries of the Iris.

Punctured Wounds of the eye frequently implicate the iris, but rarely without also injuring the crystalline lens or ciliary body, on which then the chief interest centres, as being the organs from which serious reaction is apt to emanate. If a simple incised wound of the iris be observed, it may be regarded as of little importance; for inflammatory reaction need not be feared, and any extravasation of blood in the anterior chamber (hyphæma) becomes absorbed, while, as a whole, the functions of the iris will probably not be affected.

Foreign Bodies of small size, such as bits of steel or iron, may perforate the cornea and fasten in the iris, the puncture in the cornea closing rapidly, and possibly no aqueous humour being lost. It is necessary always to remove such a foreign body, although for some time it may cause no reaction. An incision should be made with a Graefe's knife at the margin of the cornea corresponding to the position of the foreign body, and the portion

of iris containing the foreign body removed with forceps and scissors.

Blows on the Eye are apt to cause one of two remarkable lesions of the iris. The first of these is :—

Iridodialysis, *i.e.* separation of the iris from its attachment to the ciliary body, which is usually accompanied by considerable hyphæma. As much as one half of the circumference of the iris may be involved in the lesion (Fig. 74), or the latter may be so small as to be detected

FIG. 74.

only by aid of light transmitted to the eye by the ophthalmoscope, when not only the physiological pupil but also the minute marginal traumatic pupil will be illuminated. The functions of the eye after such an injury, even when extensive, may be but little disturbed.

Retroversion of the Iris is the other lesion of it to which a blow on the eye may give rise. A portion of the iris in its entire width becomes folded back on the ciliary processes, giving the appearance of a coloboma produced by a wide and peripheral iridectomy. In a true coloboma the ciliary processes would be easily seen, but not so in retroversion, for the processes being covered by the retroverted iris present a smooth surface. A slight dis-

location of the lens in the direction away from the iris-lesion is often observed.

TUMOURS OF THE IRIS.

Cysts. These vary from a very small size to that which would fill the anterior chamber. They have either serous or solid contents. The serous kind was said to result always from a trauma causing an anterior synechia, or otherwise shutting off a fold of the iris which became distended into a cyst by accumulation of aqueous humour. A case, however, which was not preceded by a trauma has come under my notice. The cysts with solid contents (epidermoid elements) are believed to have their origin in an eyelash or morsel of epidermis, which may have made its way into the anterior chamber by occasion of a perforating corneal wound. All these cysts are a source of serious danger to the eye (iridochoroiditis, glaucoma, &c.), and may even be the cause of sympathetic ophthalmitis, and hence their removal is called for. This can be effected without much difficulty if the tumour be small, but if it have attained a large size the attempt may be unsuccessful.

Granuloma is the name given to a benign neoplasm of the iris, of which the structure resembles granulation tissue. Clinically it is a small pale tumour, or there may be several, which gradually grow to fill the anterior chamber, rupture the cornea, and finally induce phthisis bulbi. It is held by some that these growths depend on a syphilitic taint, and by others that they are tuberculous.

Tubercle. This appears as small white tumours, from

the size of a pin's head to that of a pea, and larger. Microscopically they contain small round cells, and the characteristic giant cells. By early removal of the eye one may hope to avert general tuberculosis, as a case of Deutschmann's* shows.

Primary Sarcoma (or Melano Sarcoma) is a rare disease of the iris.

CONGENITAL MALFORMATIONS OF THE IRIS.

Heterophthalmos. This term indicates that the colour of the iris in one eye is different from that in the other.

Corectopia, or malposition of the pupil. The pupil sometimes occupies a position farther from the centre of the iris than normally.

Polycoria. Where there is more than one pupil. The supernumerary pupil may be separated by only a small bridge from the normal pupil, or it may be situated very near the periphery of the iris. In neither case has it a special sphincter.

Persistent Pupillary Membrane appears in the form of very fine threads stretched across the pupil and attached to the anterior surface of the iris some distance from the margin of the pupil. They do not interfere with the motions of the pupil nor with vision.

Coloboma. This is a cleft in the iris caused by an arrest of development (incomplete closure of the choroidal fissure), situated almost always in the lower inner quadrant at a position corresponding to the choroidal fissure

* *Graefe's Archiv*, Vol. XXVII. part 1, p. 317.

in the fœtus, and varying much in size. It is sometimes continued into the ciliary body and choroid, and may be present in both eyes. When uncomplicated it causes little or no defect of vision.

Irideremia, or **Absence of the Iris.** This may be complete or partial. In the latter case it may be the inner circle which is wanting, giving the pupil the appearance of dilatation with atropine. Where the entire iris is absent, the ciliary processes can be seen all round. The condition may be double-sided. The patients suffer chiefly from dazzling by light, for which either protection or stenopæic spectacles are to be prescribed.

OPERATIONS ON THE IRIS.

Iridectomy. This is performed for optical purposes, as in zonular cataract, corneal opacities, or closed pupil; for antiphlogistic purposes, as in recurrent iritis, &c.; and to reduce abnormally high intraocular tension in primary and secondary glaucoma.

The instruments required are:—A spring speculum, a fixation forceps with spring catch (Fig. 75), a lance-shaped iridectomy knife (Fig. 76) or a Graefe's cataract

FIG. 75.

knife, a bent iris forceps (Fig. 77), an iris scissors curved on the flat (Fig. 78), and a small spatula.

FIG. 76.

FIG. 77.

FIG. 78.

The width of the coloboma depends on the length of the corneal incision, and *its depth* on the proximity of this incision to the corneo-sclerotic margin. If a broad and very peripheral coloboma be desired, the incision must be long and must lie actually in the corneo-sclerotic margin, as in fig. 79. Somewhat inside the corneal margin

FIG 79.

FIG. 80.

FIG. 81.

will give a pupil, as in fig. 80. A narrow coloboma is obtained by a corneal incision, as at fig. 81, which may be more or less peripheral as circumstances require.

In glaucoma a wide and very peripheral coloboma is required. For antiphlogistic purposes a wide iridectomy is also necessary. But for optical purposes a narrow iridectomy is required, because if it be wide the diffusion of light may be very troublesome.

The position for an iridectomy for glaucoma, or for antiphlogistic purposes, is in the upper quadrant of the iris, as there the subsequent dazzling by light and the disfigurement are least; but the position, by preference, for an optical pupil is below and to the inside, being most nearly in the direction of the axis of vision. If, however, this position be occupied by a corneal opacity, the coloboma should be made directly downwards, or if that place be ineligible, then downwards and outwards, or directly downwards, or directly inwards. The upward positions are not satisfactory, owing to the overhanging

of the upper lid; but yet it often happens that we have no other choice.

In Performing an Iridectomy the eye should be fixed with a forceps at a position on the same meridian as that in which the coloboma is to lie, but at the opposite side of the cornea, and close to the latter. The point of the lance-shaped knife is then to be entered almost perpendicularly to the surface of the cornea, and made to penetrate the latter. Immediately then the handle of the knife is lowered, and the blade is passed on into the anterior chamber in a plane parallel to the surface of the iris, until the incision has attained the required length. The handle of the knife is now further lowered, so as to bring its point almost in contact with the posterior surface of the cornea, in order to prevent any injury to the lens in the next motion. The knife is then slowly withdrawn from the anterior chamber, and at the same time the aqueous humour flows off and the crystalline lens and iris fall forwards. The fixation forceps is now given over to the assistant, and the bent iris forceps, held in the left hand, is passed closed into the anterior chamber, its points directed towards the posterior surface of the cornea, so as to avoid entangling them in the iris. When the pupillary margin has been reached, the forceps is opened as widely as the corneal incision will permit, and the corresponding portion of iris is seized and drawn out to its full extent through the corneal incision. With the scissors, in the other hand, the exposed bit of iris is snipped off quite close to the corneal incision. Care should now be taken that the angles of the coloboma do not remain in the

wound; and, if they are seen to do so, they may be reposed by stroking the region of the incision with a hard-rubber spoon, or by actually pushing them into their places gently with the spatula.

CHAPTER XI.

DISEASES OF THE CILIARY BODY.

Cyclitis, or **Inflammation of the Ciliary Body** is often present to a slight degree as an extension of inflammatory affections of the iris or choroid, although its presence in many of these cases cannot be clinically determined.

Primary idiopathic cyclitis is a rare affection. Its symptoms are, marked pericorneal injection, ciliary neuralgia, and pain on pressure of the ciliary region, and opacity in the anterior part of the vitreous humour, or, perhaps, hypopion in the anterior chamber.

There are three forms of cyclitis :—

1. **Plastic Cyclitis.** Here the pericorneal injection is very decided, and there is venous congestion of the iris. The anterior chamber is deep, owing to retraction of the periphery of the iris by inflammatory exudation in the ciliary body, and for the same reason the pupil is dilated. The inflammation may extend to the iris, or to the choroid, in which latter case the vitreous may become very opaque. Violent ciliary pains attend the affection, and the eyeball is very tender on pressure of the ciliary region.

2. **Serous Cyclitis.** The pericorneal injection is but

slight. The anterior chamber is often at first deeper than normal, owing to hypersecretion of aqueous humour, or to effusion of fluid inflammatory products from the ciliary body. The anterior part of the vitreous humour is filled with a fine dust-like opacity. Serous iritis may come on, and the danger of glaucomatous increase of tension is very great. Unless increase of tension give rise to it, pain does not often attend this form.

3. **Purulent Cyclitis.** Here the pericorneal injection is very well marked. The vitreous humour is filled with membraneous opacities. There is hypopion in the anterior chamber, which has the characteristic of appearing and disappearing at intervals of a few days. There is severe ciliary neuralgia. Purulent iritis, or choroiditis, or both, are apt to supervene.

Prognosis. In an early stage all these forms are capable of undergoing cure, and of leaving the eye in a fairly useful condition. On the other hand, serous cyclitis, as already stated, is liable to produce secondary glaucoma; while the purulent form leads to atrophy of the iris and choroid, disorganisation of the vitreous humour, detachment of the retina, cataract, and phthisis bulbi; and the plastic form, in addition to serious damage to the affected eye, similar to that produced by purulent cyclitis, has, more than either of the other forms, the tendency to cause sympathetic uveitis of the other eye. The shrunken eyes resulting from this affection are often very liable to attacks of inflammation, and frequently remain painful to the touch; circumstances which indicates that chronic cyclitis still smoulders within. Such stumps are a constant source of danger to the sound eye.

Causes. Traumata are the most common causes of cyclitis. The purulent form is liable to occur after cataract operations.

The Treatment for cyclitis is similar to that for iritis. Leeching at the outer canthus is often of great benefit. For the indications for removal of eyes likely to give rise to sympathetic ophthalmitis, see chapter on the latter subject (Chap. XIII. p. 229).

INJURIES OF THE CILIARY BODY.

Punctured Wounds, and Foreign Bodies perforating the sclerotic at a distance of about 5 mm. around the cornea are almost certain to implicate the ciliary body. If there be no prolapse of the ciliary body, nor any foreign body in the interior of the eye, the sclerotic wound may heal by aid of a bandage without further ill results. If a prolapse of the ciliary body or iris be present, it is to be abscised; and if the sclerotic wound be large, it may be thought desirable to unite its margins with sutures. Wounds of the ciliary body are apt to cause cyclitis, especially if the former be caught in the sclerotic wound in healing, or if a foreign body be present in it, or indeed anywhere within the eye; and this traumatic cyclitis is more likely to produce sympathetic ophthalmitis than the idiopathic form. Hence a region around the cornea about 5 mm. wide is aptly termed by Nettleship the "Dangerous Zone."

CHAPTER XII.

DISEASES OF THE CHOROID.

Disseminated Choroiditis. The usual ophthalmoscopic appearances of this disease consist, either in round white spots of different sizes with irregular black margins, or, in small spots of pigment, these changes being surrounded by healthy choroidal tissue. Or, there may be few or no white patches, but rather spots of pigment surrounded by a pale margin. The number of these patches or spots varies according to the intensity of the disease. Their position is at first at the periphery of the fundus, but later on they appear also about the posterior pole of the eye.

These appearances represent a rather late stage of the disease, the early stage not usually coming under observation. It consists in small circumscribed plastic exudations into the tissue of the choroid, which, seen with the ophthalmoscope, give the appearance of pale pinkish-yellow spots. The exudations may undergo absorption, leaving the choroid in a fairly healthy state, but more usually they give rise to atrophic cicatrices, in which the retina becomes adherent, with proliferation of the pigment epithelium layer in their neighbourhood, and hence the white patches with black margins above described.

Sometimes, in addition to the above changes, the pig-

ment epithelium layer all over the fundus becomes atrophied, exposing to view the vascular network of the choroid, while here and there small islands of pigment are present.

Opacities in the vitreous humour are sometimes found.

Choroiditis Areolaris is the name given by Förster* to a special variety of disseminated choroiditis, which attacks chiefly the neighbourhood of the macula lutea and papilla, while the periphery is relatively healthy.

Central Senile Choroiditis. Under this name it is probable that more than one disease is included, but confined in each instance to the region of the macula lutea, or to the space between it and the optic papilla. One of the most common conditions is an appearance described, amongst others, by Mr. Warren Tay, and consisting in fine white glistening dots, only to be seen in the upright image. These dots are due to colloid degeneration with chalky formations in the vitreous layer of the choroid,† which give rise to secondary retinal changes. The functions of the retina suffer, so that a partial central scotoma may be produced.

In other cases the diseased process seems to be rather of the nature of an atrophy of the choroid, possibly of an inflammatory origin, which goes on to more or less complete destruction of the choroidal tissue at this place, with absolute central scotoma.

This disease (or diseases) attacks both eyes, either simultaneously or with an interval, and is most often

* Ophthalmologische Beiträge. Berlin, 1862.

† Hirschberg, and others. *Centralbl. f. prakt. Augenheilkunde,* Feb. 1884.

seen in persons of advanced life, although also found in middle age, and even in youth. It should always be looked for in cases of incipient cataract, for when the lental opacity is more advanced it cannot be seen, while functional examination does not then detect it.

Treatment is of no avail.

Specific Disseminated Choroiditis, or *Specific Choroido-retinitis* (see Diseases of the Retina, Chap. XVIII.).

Causes. Disseminated Choroiditis is due to acquired syphilis in a considerable number of cases. It may also be due to distension of the tunics of the eyeball in high myopia, or to hypertrophy of the hyaloid membrane in old people, or to recurrent fever. In a very large proportion of cases no ascertainable cause exists, and these Adamük * strongly suspects to be congenital, and probably many of them dependent on an inherited syphilitic taint. The etiology of choroiditis areolaris, and of central choroido-retinitis is still uncertain.

Treatment. The most beneficial treatment, when the patient's general health admits of it, is a mercurial one. Small doses of the perchloride in chronic cases, or mercurial inunctions in the more acute cases. Arsenic and iron internally, or strychnine hypodermically, would form the best tonic treatment if such were preferable.

Purulent Choroiditis. This consists at first in a purulent extravasation between the choroid and retina, and into the vitreous humour, recognizable by the yellowish reflection obtained from the interior of the eye on illuminating it. The eyeball may become hard, the

* *Centralblatt f. pract. Augenheilkunde*, 1881, p. 71.

pupil dilated, and the anterior chamber shallow. Purulent iritis with hypopion soon comes on, and the cornea may also become infiltrated and slough away. There is usually considerable chemosis. The eyeball is pushed forwards by inflammatory infiltration of the orbital connective tissue. The eyelids are swollen and congested. There is intense pulsating pain in the eye, and radiating pains through the head. In this stage all the tissues of the eyeball are engaged in the inflammation, and the condition is termed panophthalmitis.

Purulent choroiditis does not always reach this latter stage, but may remain confined chiefly to the choroid, vitreous humour, and iris. The pain in such cases is not severe, and when the affection occurs in children it may be mistaken for glioma, and the name pseudoglioma has, unfortunately, been given to it. It is distinguished from the malignant disease by the muddy vitreous usually present in it, the posterior synechiæ, and the retraction of the iris periphery, with bulging forwards of its pupillary part.

Prognosis. Be the process severe or mild, the ultimate result is phthisis bulbi. The severe cases go on to bursting of the eyeball through the cornea or sclerotic, after which the pain subsides. The shrunken eyeballs produced by panophthalmitis are not generally painful on pressure, nor are they very liable to give rise to sympathetic ophthalmitis, which latter observation is also true of the acute purulent process itself.

Causes. The most common causes of purulent choroiditis are wounds of the eyeball, whether accidental or operative (especially cataract extractions); foreign

bodies piercing and lodging in the eyeball; and purulent corneitis. It may also come on suddenly in eyes which are the subjects of peripheral prolapse of the iris; it is seen in connection with cerebro-spinal meningitis; as embolic or metastatic choroiditis in some cases of metria, similarly as purulent retinitis; in pyæmia of the ordinary type; and in endocarditis.

In infancy and childhood, besides its occurrence with cerebro-spinal meningitis, whether epidemic or sporadic, it has been known to be caused by or associated with inherited syphilis, measles, bronchitis, diarrhœa, whooping cough, and omphalophlebitis, and it is more than probable that some infectious blood disease is the fundamental cause of all these cases, although it may not be possible to detect its existence in every instance.

Treatment is powerless in this disease. The most one can do is to try to diminish the pain by warm fomentations, poultices containing powdered conium leaves, hypodermic injections of morphium, or, finally, by giving exit to the pus by an incision through the sclerotic. Enucleation of the eyeball should not be undertaken during purulent choroiditis in the acute stage, as it is liable to lead to purulent meningitis and death.

Anterior Sclero-Choroiditis is an inflammatory affection of a circumscribed portion of the anterior part of the choroid and corresponding part of the sclerotic. The latter, at the affected place, becomes swollen and congested, and of a bluish or purplish hue. The tension of the eye increases, the pupil is often dilated, the anterior chamber deep, the iris discoloured, at the side where the sclerotic swelling is situated posterior synechiæ may form, and the

cornea at the same place is liable to become opaque. There may be one or several such circumscribed tumefactions around the cornea.

Owing to the high intraocular tension, and to the degeneration of the sclerotic tissue at the affected place, the latter becomes thinned and prominent, forming what is known as anterior staphyloma. The intraocular tension is not always increased; but in those cases even the normal tension is often sufficient to distend the attenuated sclerotic. The staphyloma is of a bluish hue, owing to the choroid being seen through the thin sclerotic. If the process be rather acute there is usually severe pain, but if, as is more common, it be chronic, there is no pain. Sometimes the staphyloma is extremely sensitive to the touch, and violent ciliary neuralgia is present. Once commenced, a staphyloma may increase to a very large size.

Vision is gradually lost by increased tension, or by opacity of the vitreous and aqueous humours, with opacity of the cornea. The process may cease, the eyeball remaining of large size, or the globe may ultimately become soft and phthisical, or it may burst and then become phthisical.

Treatment is only of use in the early stages, and then antiphlogistic measures should be adopted :—Heurteloup's leech to the temple; perchloride of mercury internally; pilocarpine hypodermically. Increased tension demands an iridectomy. In advanced staphylomatous stages enucleation is often called for, to rid the patient of a useless and disfiguring organ.

Posterior Sclero-Choroiditis, or **Posterior Staphyloma.** This condition is described in connection

with myopia (Chap. II. p. 33) which is its almost constant cause.

Rupture of the Choroid is often produced by blows on the eye, and is seen as a whitish-yellow (the colour of the sclerotic) crescent some two or three papilla diameters in length, and one or so distant from the optic entrance, the concavity of the crescent directed towards the papilla. Immediately after the accident extravasated blood sometimes prevents a view of the rupture. Some choroiditis may result, but, when this passes away, good vision is frequently restored and maintained, provided detachment of the retina (Sæmisch) does not ultimately supervene from cicatricial contraction at the seat of the rupture.

Treatment. Careful protection of the eye and abstinence from use of it, with dry cupping at the temple.

Tubercle of the Choroid is sometimes seen in acute miliary tuberculosis as round, slightly prominent, pale yellowish spots of sizes varying from 0·5 to 2·5 mm. in diameter, situated always in the neighbourhood of the optic papilla and macula lutea, and unaccompanied by pigmentary or other choroidal changes. There may be but one of them, or they may be many. They occur, as a rule, in a late stage of the general disease, but have occasionally been noted long before its appearance.

Tumours of the Choroid. *Sarcoma.* This is by far the most common neoplasm of the choroid, and, when highly pigmented, is termed melano-sarcoma. It may originate in any part of the choroid, or in the ciliary body. If seen in a very early stage, it is easily recognised from its projecting over the general surface of the fundus; but, unless it be in the region of the macula lutea, it may not

cause any serious disturbance of vision, and hence may not at that period be brought under the notice of the surgeon.

The new-growth soon gives rise to detachment of the retina by reason of serous exudation from the choroid, and this is accompanied by opacity in the vitreous humour, which renders the diagnosis with the ophthalmoscope difficult or impossible. If the detachment be shallow and the retina translucent, the tumour may still sometimes be seen through the subretinal fluid by aid of strong illumination, and even direct sunlight may be employed in some such cases. Owing to the great defect of vision which comes on in this stage, we very commonly see these cases then for the first time. The history of the case may aid us, and the absence of the more usual causes of detachment of the retina should make us suspicious of an intraocular tumour.

Soon the intraocular tension increases, and this makes the diagnosis again more easy in many cases, for the combination of detached retina and increased tension exists only with intraocular tumours. The increased tension may come on very slowly and without ciliary neuralgia, or more rapidly and with all the signs and symptoms of acute glaucoma. Still, if the case come now under observation for the first time, the diagnosis may be by no means easy should the refracting media be opaque (as always in acute glaucoma), and that, consequently, the detachment of the retina cannot be observed. Here again, the history of the case is all we have to depend on, especially the fact of the patient having noticed a defect at one side of his field of vision previous to the onset of glaucoma.

In the next stage of the growth it perforates the cornea or sclerotic, and, increasing rapidly in size, although still covered with conjunctiva, it pushes the eyeball to one side, the upper lid being stretched tightly over the whole. On raising the lid the tumour is seen as a bluish-grey mass of irregular surface. The conjunctiva is now soon perforated, and the surface of the tumour becomes ulcerated, with a foul-smelling discharge and occasional hæmorrhages. The tumour gradually invades the surrounding skin and the bones of the orbit, and, by extending through the sphenoidal fissure and optic foramen, reaches the base of the brain.

It is, usually, when the neighbouring tissues of the eyeball have become involved, that secondary growths begin to form in other organs, the one most likely to be affected being the liver. The lungs, stomach, peritoneum, spleen, and kidneys may all be attacked.

The entire progress of such a growth varies considerably. It may occupy but a few months, or it may extend over many years.

Treatment. So long as the tumour is wholly intraocular, enucleation of the eyeball should be performed, and may be done with fair hopes of saving the patient's life. When the orbital tissues have become involved, extirpation of all the contents of the orbit, and even, if necessary, removal of portions of its bony walls should be undertaken, if the general health permit, in order to rid the patient of his loathsome disease; although the probable presence of secondary growths elsewhere render small the prospect of saving the patient's life.

Other, but rare forms of tumour of the choroid and ciliary body are :—

*Sarcoma Carcinomatosum,** *Myosarcoma of the Ciliary Body,*† and, in a case of the author's, *Osteo-Sarcoma.*‡

Congenital Defects of the Choroid. *Coloboma.* This is a solution of continuity occurring always in the lower part of the choroid, and usually associated with a similar defect in the iris. It may commence at the optic papilla and involve the ciliary body also, and even the crystalline lens may have a corresponding notch; or, it may not extend so far in either direction. The condition is recognized ophthalmoscopically by the white patch due to exposure of the sclerotic where the choroid is deficient. Sometimes the retina is also absent, a circumstance which may be ascertained by the arrangement of the retinal vessels; but, even if it be present, its functions at the place are wanting, and a defect in the field of vision exists. Central vision is often normal.

Albinismus, or the want of pigment in the choroid and iris. This is usually accompanied by defective pigmentation of the hair of the body. The iris has a pink appearance due to reflection of light from its blood-vessels and from those of the choroid, and the latter vessels can be seen down to their finest branchings. The light falling into the eye, not being partially absorbed by pigment, causes the patient much dazzling, and high

* *v. Graefe's Archiv,* X. i. p. 179; Landsberg, *Archiv f. Ophthal.* XI. i. p. 58; Swanzy, *Trans. Acad. Med. in Ireland,* i. p. 47.

† Iwanoff, *Compt Rendu du Congrès Internat. Ophthal.* 1868.

‡ Leber, *Bericht der Heidelberger Ophthal. Gesellsch.* 1883.

degrees of the condition are usually accompanied by nystagmus. In childhood the albinismus and attendant symptoms are more marked than later on, when some degree of pigmentation usually takes place.

Much advantage may be derived in many of these cases by the use of stenopæic spectacles, at least for reading, etc. Any defect of refraction should be carefully corrected.

CHAPTER XIII.

SYMPATHETIC OPHTHALMITIS.

By this term we understand a uveitis (irido-cyclitis, irido-choroiditis) caused by an iridocyclitis of the other eye, the latter being usually of traumatic origin.

The affection owes its name to the theory, until recently held, that it was due to reflex action of the ciliary nerves. Although this view, which is no longer in accord with modern pathology, has given place to another, yet the original name of the disease is retained, and we speak of the secondarily affected eye as "the sympathising eye," while the injured eye is called "the exciting eye."

The cyclitis most likely to cause sympathetic ophthalmitis is that set up by a punctured wound of the eyeball, especially a wound of the ciliary body itself, and the danger is still greater if the lens be also wounded, for the consequent swelling of the latter is an additional source of irritation to the ciliary body. The cyclitis set up by a foreign body which pierces the tunics of the eye and lodges in its interior is also of serious import. Yet slight injuries, and even simple incisions of the cornea,* may form the starting point of sympathetic ophthalmitis.

Traumatic dislocation of the lens, so that it may act as

* G. Critchett, *Ophth. Hosp. Rep.* Vol. X. p. 142.

a foreign body in the eye, although without rupture of the tissues of the eyeball, may induce cyclitis capable of exciting sympathetic ophthalmitis, as also may cyclitis caused by a blow on the eye (closed fist, cork of champagne bottle, etc.). Brailey is of opinion* that, generally speaking, eyes containing bone, although usually exciting sympathetic irritation very strongly, rarely excite sympathetic inflammation; probably because in them the stage of active inflammation has passed; or else, that the kind of inflammation which gives rise to the formation of bone, is not the one most likely to cause sympathetic ophthalmitis.

The cyclitis of the exciting eye may be but slight, so slight indeed that vision is not seriously affected, or it may be severe. The degree of severity of the attack in the sympathising eye does not depend on that of the inflammation in the exciting eye; for, in many cases, the process in the sympathising eye is a more severe one than that in the exciting eye.

Sympathetic Irritation or Neurosis is a condition of the second eye frequently seen, and which must not be confounded with sympathetic ophthalmitis, nor is it to be regarded as a premonitory sign of the latter, for it may pass away without leaving any organic changes behind it. It consists in photophobia, tearing, pericorneal injection, and accommodative asthenopia, and is very probably a reflex neurosis.

Premonitory Sign of Sympathetic Ophthalmitis. Shrinking pain (the patient draws back his head in a most characteristic way) on pressure of the ciliary region of

* *Trans. Int. Med. Congress*, 1881, Vol. III. p. 38.

the exciting eye is almost always present, where sympathetic ophthalmitis supervenes; but there are no premonitory signs in the sympathising eye prior to the attack of inflammation in it.

Progress of Sympathetic Ophthalmitis. The process commences usually as a serous irido-cyclitis, with increased depth of the anterior chamber and keratitis punctata, and may maintain this character to the end. As a rule it soon passes over to a plastic form with development of new vessels in the iris, and shallowness of the anterior chamber. The tissue of the iris and ciliary body become infiltrated with lymph cells, and on their posterior surfaces and in the pupil a deposit of lymph cells takes place, the choroid also becoming similarly infiltrated, and connective tissue is developed in this exudation. The vessels of the uveal tract are destroyed by pressure of the newly developed connective tissue; the vitreous humour consequently shrinks, causing detachment of the retina, cataract, and phthisis bulbi.

Or, the process may be confined chiefly to the anterior segment of the eyeball, the iris, ciliary body, and lens, and may cause merely disorganization of those parts with shallow anterior chamber, a condition known as phthisis anterior, while the vitreous humour, retina, and choroid remain healthy.

Slight optic neuritis has been noticed in the sympathising eye in some cases prior to, or simultaneously with, the outbreak of irido-cyclitis, and is probably of tolerably constant occurrence.

The shortest period at which, after irido-cyclitis had been set up in the injured eye, sympathetic ophthalmitis

appeared, is twelve or fourteen days, and cases have been recorded in which the interval was forty years. The most usual interval is six to eight weeks.

Nature of the Disease. The investigations of Knies,* Leber,† Brailey,‡ Snellen,§ MacGillavry,|| and Berlin ¶ indicate, that sympathetic ophthalmitis is an inflammation propagated to the sympathising eye by direct continuity through the optic nerves and chiasma from the exciting eye, as erysipelas extends over the skin, and that certain bacteria are primarily engaged in the process.

Dr. Brailey** has to a certain extent receded from this view.

Treatment. The most important point is the prevention of the extension of the inflammation to the other eye. Sir W. Bowman†† has found it possible in private practice, by careful nursing for a year or more, to save eyes with severe wounds, and to prevent the occurrence of sympathetic ophthalmitis. The only certain prophylactic measure, however, and the only one applicable to the great mass of those with whom we have to deal, is timely removal of the injured eye; and a most difficult question sometimes presents itself, when, in a given case, we have to decide as to the necessity of this measure. The following rules guide me in my own practice at present:—

* *Sitzungsber. d. Ophth. Gesellsch.* 1879, p. 52.
† *A. v. Graefe's Archiv*, XXVII. i. p. 325.
‡ *Trans. Internat. Med. Congress*, 1881, Vol. III.
§ *Trans. Internat. Med. Congress*, 1881, Vol. III.
|| *Amsterdam Internat. Med. Congress*, 1879.
¶ *Volkmann's Samml. Klin. Vorträge*, No. 185, 1880.
** *Trans. Ophthal. Soc.* 13 Dec. 1883.
†† *Ophthalmic Review*, 1882, p. 228.

1. Although danger to the second eye does not arise until inflammation has been set up in the exciting eye; yet, I would perform primary enucleation of the latter, if it had been so injured as to make recovery of sight almost hopeless, and the onset of irido-cyclitis almost certain.

2. I would enucleate in the same case, were irido-cyclitis already set up in the injured eye.

3. I would enucleate in a case of irido-cyclitis where a foreign body was believed to be present in the eye, and which could not be safely extracted, even though the vision were fairly good; because, we know that here the danger of sympathetic ophthalmitis amounts almost to a certainty.

4. I would enucleate in a case of acute irido-cyclitis, traumatic or idiopathic, where vision was lost, especially if the eye were tender on pressure; for here the eyeball is useless and disfiguring, and apt to be a source of danger to its fellow.

5. I would enucleate in a case of phthisis bulbi, even of old standing, where there was shrinking pain on pressure, for the same reasons as in No. 4.

6. I would enucleate in a case where the sympathising eye is already affected, provided vision in the exciting eye be lost, and hopes of its recovery but slight, if any; for improvement in the sympathising eye, or a greater amenability of it to treatment, has been frequently observed after this has been done. Brailey, however, holds, that enucleation is not in this instance to be recommended, as he believes it tends to aggravate the condition of the sympathising eye, to change a serous into a plastic uveitis.

7. I would enucleate in a case of sympathetic irritation, if the sight of the exciting eye were very defective, and the neurosis very persistent.

1A. I would not remove any injured eye, unless it contained a foreign body which I could not remove, if its sight were fairly good, and as yet no sign of inflammation in it. For inflammation may not come on, and the eye may possibly be saved.

2A. I would not enucleate the exciting eye if sympathetic ophthalmitis had already appeared, should the vision of the exciting eye be fairly good. (Contrast this with Rule 6.) For it often occurs, that the process in the sympathising eye is not arrested by the proceeding, and that, where the latter is not undertaken, the exciting eye turns out in the end to be the organ with the better vision.

Cases have been observed in which sympathetic ophthalmitis broke out some days after removal of the exciting eye. In these instances the inflammation no doubt had already started on its journey from the exciting eye, the removal of which did not arrest its progress. Inasmuch then as the inflammation takes at least fourteen days (*vide supra*) to travel from one eye to the other, one cannot feel certain of having averted sympathetic ophthalmitis before that period at least has elapsed; and it is well to impose abstinence from use of the eye, or exposure of it to much light for that time or longer. This fact is not to deter from the enucleation when indicated, for in the vast majority of cases it has the desired effect, and even in the cases referred to the inflammation in the second eye has usually been of a mild type, and has yielded readily to treatment.

Division of the optic and ciliary nerves in the orbit has been tried as a substitute for enucleation, and is still practised by some surgeons. By many it has been abandoned as not affording the protection of enucleation, for the cut ends of the nerves reunite, and at least one case * has been observed, in which, several months after the optico-ciliary neurotomy, sympathetic ophthalmitis appeared.

Sympathetic ophthalmitis having broken out, and the question of enucleation having been decided one way or the other, the measures to be directed against the process in the sympathising eye have to be considered. The patient should be confined to a dark room, and atropine used for the eye, while the general system is maintained by a tonic but non-stimulating treatment. It is doubtful whether other means are of much value. Von Graefe prescribed mercurialization in these cases, and it is still extensively employed in Germany. Possibly pilocarpine might be of use.

No operation should be undertaken for the formation of an artificial pupil in the sympathising eye until the inflammatory process has completely subsided, the tension of the eye improved, and the vascularity of the iris diminished, *i.e.*, until the active inflammatory process has quite passed away. This period G. Critchett † reckoned at from twelve to eighteen months after the onset of the disease. If operative interference be resorted to during that period, the result is an aggravation or rekindling of the inflammation and closure of the artificial pupil which

* Leber, *A. v. Graefe's Archiv*, XXVII. i. p. 339.

† *Ophthal. Hosp. Rep.* Vol. X. p. 143.

may have been made, in consequence of proliferation of the layer of retro-iritic connective tissue.

Of the operations employed for the establishment of an artificial pupil in an eye which has suffered from sympathetic ophthalmitis resulting in anterior phthisis, iridectomy most naturally suggests itself, and is the least satisfactory. The reason of this is that, owing to its very disorganized state, the iris tears when drawn on by the forceps; and hence, the formation of a satisfactory coloboma is almost impossible; and, even if this be obtained, it is extremely liable to close again, from proliferation of the retro-iritic connective tissue set going anew by the irritation of the operation. Sometimes, after repeated iridectomies, a permanently clear pupil is obtained.

Von Graefe operated by making a peripheral linear incision as for cataract, but passing the knife behind the iris, and in doing so opening the capsule of the lens. An iridectomy is then made by seizing a wide portion of the iris and corresponding retro-iritic connective tissue, one blade of a special forceps being passed behind these structures, while the other blade enters the anterior chamber, and then drawing the iris, etc., out and cutting off the exposed portion. The partially or completely opaque lens, or a considerable portion of it, becomes evacuated during this proceeding, or, if not, the usual measures are taken to extract it. With this method, also, the pupil frequently closes again, and even more than one supplementary iridectomy or iridotomy may be required, but must not be undertaken until all irritation subsides. The iridectomy as above described is now with advantage

often replaced by a V-shaped one, made with de Wecker's forceps-scissors.

The late Mr. Critchett's Method * for the formation of a pupil in these cases consists in passing a needle by a boring motion through the iris, retro-iritic tissues, and lenticular capsule; another needle is passed in close to the first, and then by separating one point from the other a rent is made in the centre. This is followed generally by the escape of a small quantity of cheesy lens matter. The latter is allowed to become gradually absorbed, and in the course of some weeks the capsule closes again. The operation has to be repeated several times before a clear pupil is obtained, care being taken that all irritation from the previous operation has subsided before another is undertaken.

Enucleation of the Eyeball is usually performed by Bonnet's method. With a forceps a fold of conjunctiva is seized over the insertion of the internal rectus muscle, as if for strabotomy, and incised with a scissors, which is then passed under the conjunctiva, and the subconjunctival tissue extensively divided. A strabismus hook is now introduced under the insertion of the tendon, which is then separated off from the sclerotic. The conjunctiva is then divided along the corneal margin in the direction of the superior rectus, which is separated from the eyeball, and so on for each rectus muscle in its turn. With a strong forceps the insertion of the external rectus is now seized, and the eyeball drawn well forwards and inwards, so as to admit of a strong scissors curved on the flat being passed behind it, and the optic nerve is divided close to

* *Ophthal. Hosp. Rep.* Vol. X. p. 141.

the globe. The eyeball can then be completely dislocated, and the operation completed by separating the obliqui close to their insertions. Some surgeons draw the edges of the conjunctival wound together with sutures. The slight hæmorrhage which usually ensues can readily be arrested by a stream of cold water poured into the orbit, and a pledget of lint soaked in carbolized oil having been laid over the lids, a bandage is applied, and healing is complete in a few days. An artificial eye can usually be inserted after a fortnight, but should not be constantly worn for at least a month.

CHAPTER XIV.

THE MOTIONS OF THE PUPIL IN HEALTH AND DISEASE.

The Size of the Pupil in Health depends chiefly on the intensity of the light to which the eye is exposed, contracting when light falls into the eye, and dilating in the shade. However defective vision may be, if quantitative perception of light still remains, the reaction of the pupil as a rule takes place.

Contraction of the Pupil. Contraction to light is a reflex motion, the optic nerve being the afferent nerve, and the third nerve the efferent nerve innervating the sphincter pupillæ. The anatomical investigations of Meynert * have shown, that between the corpora quadrigemina and the centre for the third nerve in the floor of the fourth ventricle run communicating fibres, which probably enable this reflex to take place. Owing to the semi-decussation of the fibres in the optic chiasma, the stimulus of light, when applied to one eye alone, passes up each tractus with equal power to the corpora quadrigemina of each side by Meynert's fibres, to the centre for the third nerve, and thence down the pupillary branches to each eye, causing as active a contraction of the pupil in the non-illuminated eye (consensual contraction) as in its fellow. It is probable, however, as Leeser† points out, that, in addition to this method of bringing about consensual contraction of the pupil, there is a communication, direct or indirect, between the centres for the third nerve of each side capable of effecting it. In no other way can the fact be explained, that consensual contraction of the pupil is maintained in cases of homonymous hemianopsia. If, for instance, there be a lesion of the

* Vom Gehirn der Säugethiere. *Stricker's Handbuch.* Leipzig, 1870.

† Die Pupillarbewegung in Physiologischer und Pathologischer Beziehung. Wiesbaden, 1881, p. 14.

right tractus opticus giving rise to left hemianopsia, the centre of the left third nerve alone can be primarily stimulated; but, as both pupils act, a communication between the centres of the third nerves must exist. Merkel* believes that there is a direct anastomosis between these centres.

In addition to the stimulus of light, the pupil contracting centre is excited by, or simultaneously with the effort of accommodation for near vision. The object of this contraction is to cut off rays falling on the peripheral portions of the lens, which latter are not curved in the change for accommodation to the same degree as is the centre of the lens. This contraction, however, is much more intimately connected with convergence of the visual lines than with the effort of accommodation. Adamük and Woinow† showed that the contraction increased with the effort of accommodation, but not proportionately to the distance of the fixation point from the eye. E. H. Weber‡ asserts that the pupils do not contract if accommodation be effected without convergence, but that in convergence without accommodation contraction is observed. Adamük and Woinow found that the contraction was proportional to the degree of convergence, and that in myopes of high degree contraction of the pupil takes place at the other side of the far point, where of course the accommodation does not come into play. Aubert§ thinks there is probably a common centre for the three actions, convergence, accommodation, and pupil-contraction, a view supported by Priestly Smith ;‖ and Hensen and Volckers¶ have found that in dogs, in the posterior part of the floor of the third ventricle, the centres for the branches to the ciliary muscle, the sphincter pupillæ, and the rectus internus occur in close succession, and think that this region may be regarded as the centre assumed by Aubert. The existence of such a centre has been placed beyond controversy by Eales' case** of paralysis of convergence and accommodation, and of the associated pupillary contraction. These three motions, then, are not dependent on each other, but are co-effects of one and the same cause, *i.e.*, a stimulus applied to the centre for convergence, accommodation, and pupil contraction.

* *Graefe und Sæmisch's Handbuch*, Vol. I.

† *Archiv für Ophthalmologie*, XVII. i.

‡ De motu iridis. Lipsiae, 1851.

§ *Graefe und Sæmisch Handbuch*, II. p. 669.

‖ *Ophthal. Hosp. Rep.* Vol. IX. p. 32.

¶ *Arch. f. Ophthal.* XXIV. i. p. 23.

** *Trans. Ophthal. Soc.*, 10 Jan. 1884.

Dilatation of the Pupil is the result of contraction of the dilatator pupillæ innervated by the tonic action of the cervical sympathetic. The dilating fibres, originating (Hensen and Völckers) in the front part of the floor of the aqueduct of Sylvius, pass to a region in the lower cervical and upper dorsal portion of the cord, called by Budge* the ciliospinal centre, and from thence pass out with the two first dorsal nerves, and by way of the rami communicates to the sympathetic in the neck, and thence to the cavernous plexus, gasserian ganglion, ophthalmic division of the fifth nerve, nasal branch of this division, ganglionic branch of this nerve, ciliary ganglion, there joined by more branches from the cavernous plexus, and from thence by the short ciliary nerves reach the eye.

The dilating fibres are probably of twofold nature, muscular and vasomotor. The experiments of Grünhagen,† Salkowski,‡ Donders and Hamer,§ Stellwag,‖ and F. Arlt, jun.¶ indicate this, and that the centre for each kind of fibre is different, though both are situated in the medulla oblongata, and their fibres probably run the same course to the eye. The centre for the muscular fibres is called the oculo-pupillary centre. That the vasomotor fibres have a decided and independent influence in dilating the pupil has been shown by Rouget,** Schoeler,†† and others. It is not certain what the mechanism of this influence may be, but it probably consists in a diminution in volume of the iris from anæmia caused by contraction of the muscular coat of the vessels.

While light is the only stimulus capable of bringing about a reflex contraction of the pupil, the pupil-dilating centre reacts to every sensitive stimulus, *e.g.*, galvanism applied to the leg,‡‡ the tickling of a sensitive place in the region of the fifth nerve on the face,§§ etc., and Westphal‖‖ observed dilatation on shouting loudly into the ear of a person under chloroform. Schiff and Fou¶¶ found that in curarized dogs and cats a dilata-

* Ueber die Bewegungen der Iris, 1855.

† *Zeitschrift f. rat. Med.* XXVIII.

‡ *Zeitschrift f. rat. Med.* XXIX. p. 167.

§ *Nederl. Tijdschr. v. Geneesk*, 1864.

‖ Ueber Atropin. *All. Wiener Med. Zeitung*, 1872, p. 146.

¶ *Archiv für Ophthal.* XV. i.

** *Comptes rendus et Mém. de la Soc. de Biologie*, 1856.

†† Experimentelle Beiträge zur Irisbewegung: Inaug. Diss. Dorpat, 1869.

‡‡ Arndt *Griesenger's Archiv f. Psych.* II.

§§ Hecker *Tageblatt der 45 Versam. deutscher Naturforscher in Leipzig*, 1872.

‖‖ *Virchow's Archiv*, XXVII. p. 409.

¶¶ La pupilla come estesiometro. *L'Imparziale*, 1874.

tion took place on the application of every stimulus, not necessarily painful, applied to the nerves of common sensation in any part of the body. The centre for this reflex is probably in the medulla oblongata,* but, inasmuch as it takes place if the cervical sympathetic be divided,† it is evident that all the dilating fibres do not run to the eye by way of the cervical sympathetic. Schiff,‡ indeed, thinks it probable, that the gasserian ganglion receives pupil-dilating fibres from the sympathetic traversing the cavum tympani.

Some psychical emotions produce dilatation of the pupil. The pupils of a cat in anger dilate, and those of a frightened child. In sleep, or when under the complete influence of an anæsthetic, the pupils are contracted, for then all psychical and sensitive stimuli are reduced to a minimum. Facts authorize the conclusion that the medium dilatation of the pupil in the healthy state depends chiefly on the intensity of these stimuli habitually transmitted through the sympathetic. If, in any individual, they be slight, his pupil is contracted ; if intense, it is dilated. Arndt§ asserts that in delicate, nervous, excitable people the pupils are often much and habitually dilated.

In addition to those already mentioned, there are causes for the dilatation of the pupil which can hardly be referred to simple reflex action, but which seem to be, like the contraction of the pupil on convergence of the visual lines, associated with those of other centres in the medulla oblongata, especially with those for respiration and uterine action. With every *deep* inspiration or expiration a considerable pupillary dilatation takes place, not identical with that slight dilatation occurring on each ordinary inspiration and depending on variation of blood pressure, but due‖ to simultaneous stimulation of the respiratory and pupil-dilating centres by retention of carbonic acid gas in the blood. Raehlmann and Witowski¶ have observed marked dilatation at the beginning of each labour pain, to be explained as an associated action of the neighbouring centres for uterine movements and pupil dilatation.

The Fifth Nerve has been held by some to have an influence over the motions of the iris similar to that of the sympathetic. This is doubtless a

* Salkowski, *loc. cit.*

† Vulpian, *Archiv de physiol. etc. de Brown-Sequard.* Janvier, 1874

‡ Untersuchungen zur Naturlehre, X., 1867, p. 423.

§ *Archiv f. Psychiatrie*, II. p. 589.

‖ Schiff, *loc. cit.*

¶ *Archiv f. Physiologie*, 1878, p. 110.

mistaken view;* the effect on the pupil following section of the fifth within the cranium, being due to paralysis of the sympathetic fibres contained in it, and not to the lesion of the proper fibres of the fifth nerve. Others† again have ascribed to the fifth nerve a direct influence over the contraction of the pupil; but this is to be regarded as a reflex action merely, Merkel indeed having demonstrated‡ the existence of direct fibrillar connection between the centres of the fifth and third nerves.

There is no absolute *Standard for the Physiological Size of the Pupil.* The latter varies in different healthy individuals, being in general smaller in elderly people, and in those with blue irides, than in youthful subjects and those with dark pigmentation. Woinow§ found the diameter of the pupil when the accommodation was at rest to vary between 2·44 and 5·82 mm., giving an average diameter of 4·14 mm.

Action of the Mydriatics on the Pupil. *Atropine.* Inasmuch as a maximum mydriasis can only result from paralysis of the sphincter iridis combined with contraction of the dilatator iridis, and as atropine effects such a mydriasis, it is evident it acts in the way indicated on these muscles, or rather on the peripheral endings of the nerves which supply them.‖ A. von Graefe proved¶ that the aqueous humour of an eye into which atropine has been instilled, acts as a mydriatic when applied to another eye. *Duboisin*, *Hyoscyamin*, and *Daturin* act similarly to atropine. Strychnine and curare are not strictly speaking mydriatics, as they only indirectly affect the pupil; the mydriasis observed in poisoning by these drugs being, according to Schiff** and others, the result of the retention in the blood of carbonic acid gas.

Action of the Myotics on the Pupil. *Eserine* (or *Physostigmine*). This drug is in all respects a complete antagonist of atropine,†† paralysing the peripheral endings of the sympathetic in the dilatator pupillæ, and stimulating the endings of the branch of the third nerve in

* Leeser, *loc. cit.*, pp. 46-48.

† Grünhagen. *Berl. Klin. Wochenschr.* 1866, No. 24. Rogow, *Zeitschr. f. rat. Med.* Vol. XXIX. p. 289.

‡ *Graefe und Sæmisch's Handbuch*, I. p. 140.

§ Ophthalmometrie. Wien, 1871.

‖ Hermann, Lehrb. der exp. Toxicologie, 1874.

¶ *Archiv f. Ophthal.* I. i. p. 462, foot-note.

** *Pflüger's Archiv*, 1871, p. 229.

†† Harnack *Arch. f. exp. Pathol.* II. p. 307, A. Weber, *Archiv f. Ophthal.* XXII ii., p. 231.

the sphincter pupillæ. *Pilocarpine* and *Muscarine* act similarly, but not with the same energy. *Nicotine*, applied to the eye, is found to act like eserine.* Morphium has an antagonistic effect to atropine, both as regards the pupil and the general nervous system, and is employed in cases of poisoning by atropine (*vide* p. 200).

Chloroform in the first or excitation stage of anæsthesia, according to the investigations of Westphal,† Budin,‡ and Hirschberg,§ stimulates the pupil-dilating centre, and in the second stage gradually reduces the excitability of this centre, until finally it is completely paralysed, so that no form of stimulation causes any dilatation. Following on this is a still further contraction to a pin-hole pupil, due to stimulation of the pupil-contracting centre. Should the inhalation of the anæsthetic be longer continued, a dilatation of the pupil, often sudden, takes place, and this indicates paralysis of the pupil-contracting centre, and the most serious consequences for the life of the patient.

The Size of the Pupil in Disease. *Myosis* may be caused by a diseased process irritating the pupil-contracting centre or fibres (the Irritation Myosis of Leeser), or by one causing paralysis of the pupil-dilating centre or fibres (the Paralytic Myosis of Leeser), or by a combination of both. Either cause alone would produce a medium myosis; a combination of the two would give a maximum myosis.

Irritation Myosis, according to Leeser, is not usually increased by the stimulus of light, nor on convergence of the visual axes, nor does it diminish in the shade. Mydriatics dilate such a pupil widely, myotics contract it ad maximum. In paralytic myosis the pupil reacts well to light and on convergence, but does not dilate on application of sensitive or psychical stimuli, or with co-ordinated motions. Mydriatics dilate such a pupil only partially, while myotics contract it ad maximum. In maximum myosis every reaction is wanting, strong mydriatics alone producing a medium dilatation.

Irritation myosis is found in :—*a*. The early stages, at least, of all inflammatory affections of the brain and its meninges, in simple, tubercular, and cerebro-spinal meningitis. When in these diseases the medium-myosis gives place to mydriasis, the change is‖ a serious

* Rogow, *Zeitschrift f. rat. Med.* XXIX. p. 1; Schur, *Zeitschrift f. rat. Med* XXXI. p. 402.

† *Virchow's Archiv*, XXVII. p. 409.

‡ *Gazette des Hôspitaux*, 1874, p. 910.

§ *Berl. Klin. Wochenschr*, 1876, p. 652.

‖ Leeser, *loc. cit.* p. 82.

prognostic sign, indicating the stage of depression with paralysis of the third nerve. *b.* In cerebral apoplexy the pupil is at first contracted, according to Berthold,* who points out that this contraction is a diagnostic sign between apoplexy and embolism, in which latter the pupil is unaltered. *c.* In the early stages of intra-cranial tumours situated at the origin of the third nerve or in its course. *d.* At the beginning of an hysterical or of an epileptic attack.† *e.* In tobacco amblyopia,‡ probably from stimulation of the pupil-contracting centre by the nicotine. *f.* In persons following certain trades, as the result of long-maintained effort of accommodation§ (watchmakers, jewellers, &c.), the pupil-contracting centre being subject to an almost constant stimulus. *g.* As a reflex action in ciliary neurosis; consequently, in many diseased conditions of those parts of the eye supplied by the fifth nerve.

Paralytic myosis occurs :—In spinal lesions above the dorsal vertebræ, *e.g.*, injuries, and inflammations, especially of the chronic form. The contracted pupil occurring in gray degeneration of the posterior columns of the spinal cord is long known as spinal myosis. In the simple form of this myosis the pupil has but a medium contraction, and reacts both to light and on convergence. This condition is found in the early stages alone, when the disease has attacked only the cilio-spinal centre, or higher up as far as the medulla oblongata; later on, when Meynert's fibres become engaged, we have the Argyll Robertson pupil. The very minute pupil often seen in tabes dorsalis is probably due to secondary contraction of the sphincter pupillæ.‖ Argyll Robertson first pointed out,¶ that in tabes dorsalis the pupil, although contracted and responding to light but slightly or not at all, contracts on convergence of the visual axes (or accommodation). He explained this phenomenon as being due to paralysis of the cilio-spinal nerves, which he therefore regarded as the nerves supplying the sphincter iridis. Raehlmann points out** that the myosis and the motor phenomenon are not directly connected; for it sometimes happens that pupils which do not react to light and do contract on convergence are not habitually contracted, and may even be

* *Berl. Klin. Wochenschr.* 1869, No. 39.

† Wecker, *Graefe und Sæmisch's Handbuch*, IV.

‡ Hirschler, *Arch. f. Ophthal.* XVII. i.

§ Seiffert, *Allgem. Zeitschrift für Psychicatrie*, X. 1853, p. 544.

‖ Hempel, *Archiv f. Ophthal.* XXII. i.

¶ *Edin. Med. Journal*, Vol. XIV. 1869, p. 699, and Vol. XV. 1870, p. 487.

** *Loc. cit.* p. 7.

somewhat dilated. The two symptoms are, no doubt, often present together in tabes. The myosis is a sign, and an important one, of disease of the posterior columns, while the defective reaction to light with retained contraction on convergence indicates disease at some distance from the spinal cord, namely, in Meynert's fibres; and this is probably the correct explanation of the Argyll Robertson symptom. Disease in Meynert's fibres, however (as also disease of the optic nerve), may be in direct connection with disease of the cord, Stilling having found* fibres passing directly from the optic tract into the crus cerebri. Raehlmann and Drouin† regard myosis as one of the earliest symptoms of tabes, while Vincent‡ does not. Raehlmann also thinks that, perception of light being present, if the pupils do not react to light, while they do contract on convergence, the symptom is usually one of serious central disease. Paralytic myosis is also found in general paralysis of the insane. In acute mania the pupil is usually much dilated, and when this mydriasis is changed for myosis, approaching general paralysis may be prognosticated.§ Myosis, following on irritation mydriasis, is also found in myelitis of the cervical portion of the cord. In bulbar paralysis, if paralytic myosis occurs, the disease is probably complicated with progressive muscular atrophy, or with sclerosis of the brain and spinal cord.‖

Hirschler states¶ that he has frequently noticed a contracted pupil in alcoholic amblyopia, due probably to an affection of the medulla oblongata, possibly fatty degeneration. Myosis may also be due to paralysis of the cervical sympathetic, which may result from injury, from pressure of an aneurysm of the carotid, innominate, or aorta, or from pressure of enlarged lymphatic glands. In apoplexy of the pons varolii myosis is present, but it is not yet certain whether it is an irritation myosis** or a paralytic myosis.††

Mydriasis may be caused by a diseased process giving rise to irritation of the pupil-dilating centre or fibres, or by paralysis of the pupil-contracting centre or fibres.

* *Beilageheft zu Zehender's Monatsblätter*, XVII. pp. 203-207.

† *Thèse de Paris*, 1876. De la pupille.

‡ *Thèse de Paris*, 1877.

§ Seiffert, *loc. cit.*

‖ Leeser, *loc. cit.* p. 94.

¶ *Archiv f. Ophthal.* XVII. i. 229.

** Larcher. Pathol. de la protub. Annulaire, deux. tirage, p. 54.

†† Jüdell, *Berl. Klin. Wochensch.* 1872, No. 24.

The former is termed Irritation (or Spasmodic) Mydriasis, and, according to Leeser, is characterized by a moderately dilated pupil, contracting somewhat to light and on convergence, but not dilating on sensitive or psychical stimuli, easily dilated ad maximum by mydriatics, but with difficulty contracted ad maximum by myotics. The latter is called Paralytic Mydriasis, and in it there is a moderately dilated pupil, reacting to sensitive and psychical stimuli. The reaction to light and on convergence varies according to the seat of the lesion. If the latter lie between the iris and pupil-contracting centre, the direct and consensual reaction to light is wanting, as also the associated motion on convergence of the visual lines. But if the lesion lie between the retina and the pupil-contracting centre, the direct contraction to light is wanting, but the consensual contraction and that on convergence retained. In either case the pupil can be contracted ad maximum by mydriatics, but not contracted more than to medium size by myotics.

Irritation of the pupil-dilating centre and paralysis of the pupil-contracting centre existing simultaneously, give rise to maximum mydriasis. In it there is absolute immobility to stimuli of all kinds except strong myotics, which may bring it back to the normal size.

Irritation Mydriasis occurs:—*a.* In hyperæmia of the cervical portion of the spinal cord, and in spinal meningitis. *b.* In the early stages of new growths in the cervical portion of the cord. *c.* In cases of intracranial tumour and other diseases causing high intracranial pressure, according to Raehlmann, although Leeser points out that these may also give rise to paralytic mydriasis. *d.* In the spinal irritation of chlorotic or anæmic people, after severe illness, &c. *e.* As a premonitory sign of tabes dorsalis. *f.* In cases of intestinal worms, owing to the stimulation of the sensitive nerves of the bowel, and sometimes in other forms of intestinal irritation. *g.* In psychical excitement, *e.g.*, acute mania, melancholia, progressive paralysis of the insane (often then unilateral, with myosis in the other eye).

Unilateral mydriasis occurring at short intervals, now in one eye and now in the other, is, according to von Graefe,* a premonitory sign of mental derangement. Graefe observed madness in the form of manie des grandeurs to come on some months after the occurrence of this symptom.

Paralytic Mydriasis may be due either to a paralysis of the pupil-contracting centre, or as the result of the stimulus not being conducted

* *Archiv f. Ophthal.* III. iii. p. 359.

from the retina to that centre. It may be found under the former circumstances :—*a*. Sometimes in progressive paralysis where at first there was myosis. *b*. In various diseased processes at the base of the brain affecting the centre of the third nerve. *c*. In a later stage of thrombosis of the cavernous sinus.* *d*. In orbital processes which cause pressure on the ciliary nerves. *e*. In glaucoma. *f*. In cases of intraocular tumours which have attained a certain size.

In paralytic mydriasis due to non-transmission of the stimulus of light to a healthy pupil-contracting centre and nerves, contraction of the pupil will take place only on convergence of the visual lines. The same condition of pupil will be found if the lesion lie in the course of Meynert's fibres, although vision may be normal. If the lesion lie in the centre of vision (angular gyrus, &c.), or in the course of the fibres connecting this centre with the corpora quadrigemina, although absolute blindness exist, the reaction of the pupil to light will be perfect. Paralytic mydriasis due to non-conduction of light-stimulus is found in most cases of optic atrophy.

* Knapp, *Archiv f. Ophthal.* XIV. i. p. 220.

CHAPTER XV.

GLAUCOMA.

Symptoms. The chief and almost essential symptom of this disease is :—

I. Increased intraocular tension, increased hardness of the eyeball.

If the tips of the index fingers of each hand be placed close together on a normal eyeball, and gentle pressure made with them alternately, it will be found that the eyeball pits slightly on this pressure, and that a sensation of fluctuation is given to the fingers. The amount of this pitting or fluctuation varies according to the degree to which the eyeball is filled with its fluids, and also, to some extent, according to the thickness of the sclerotic coat, and is not precisely the same in every normal eye.

Some clinical experience is necessary, before the surgeon can appreciate by palpation those degrees of tension which are just above or below the normal, and no other method is equally satisfactory. Tonometers have indeed been invented for the purpose, but the results obtained by them are unreliable. For the purpose of clinical notation Sir W. Bowman suggested some signs, which have been very generally adopted. Normal tension he indicates by the letter T, slight increase of

tension = T + 1, still higher tension = T + 2, while T + 3 indicates stony hardness of the eyeball. In the same way diminished tension is T − 1, T − 2, and T − 3.

The other symptoms of glaucoma are largely due to the increased tension. They are:—

II. Diminished depth of the anterior chamber, from pushing forwards of the lens and iris.

III. Diminution of the refracting power of the eye, by reason of the nearer approach of the latter to a globular shape.

IV. Diminution of the amplitude of accommodation and anæsthesia of the cornea, owing to pressure on the ciliary nerves as they pass along the inner surface of the sclerotic.

V. Opacity of the cornea, giving its surface a peculiar "steamy" or "breathed on" appearance, due, according to Fuchs,* to œdema of the corneal tissue and epithelium by infiltration of the intraocular fluids from high tension.

VI. Dilatation and immobility of the pupil, the result, according to some, of paralysis of the ciliary nerves, but according to others, of anæmia of the iris from pressure on its vessels.

VII. The violent pain, seen in cases where the tension has risen suddenly, is also due to irritation of the ciliary nerves.

VIII. The episcleral veins are large and tortuous, owing to the pressure on the vasæ vorticosæ preventing the discharge by those channels of the choroidal venous blood, which must then pass off by the anterior ciliary veins.

IX. A pulsation of the arteries on the optic papilla may be often noted; or, if not present, may be easily

* *Bericht der Ophthl. Gesellsch. zu Heidelberg*, 1881.

produced by very slight pressure with the tip of a finger on the eyeball; because blood can only be forced into these vessels by a pressure greater than that opposed to it. In the normal eye there is no arterial pulsation, because the tension of the coats of the vessels is greater than the intraocular tension, and therefore the blood passes on in a continuous stream; but in the glaucomatous eye the intraocular tension opposes so great an obstacle to the arterial flow, that at the systole alone can it make its way through.

X. The optic papilla, being the weakest part of the ocular wall, is the first place to give way to the high tension, and it becomes depressed or cupped, the excavation being often deeper than the outer surface of the sclerotic, and the lamina cribrosa being pushed back (Fig. 82). This

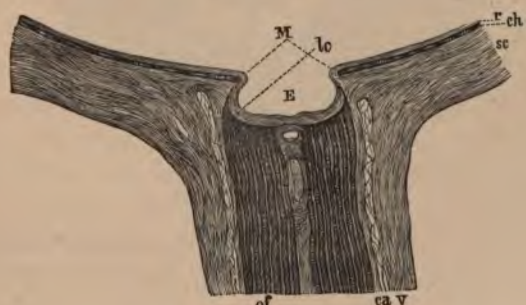


FIG. 82. (*Ed. Jaeger.*)

sc. Sclerotic; ch. Choroid; r. Retina; of. Optic Nerve; ca. Intervaginal Space; v. External Sheath of the Optic Nerve; E. Excavation of the Papilla; M. Margin of the Excavation; lc. Lamina Cribrosa.

cupping of the papilla is a most important sign of glaucoma, and differs essentially in appearance from the

physiological cupping, inasmuch as it occupies the entire area of the papilla, and has steep, not shelving sides. As shown in Fig. 82, the walls of the excavation are often hollowed out, and the ophthalmoscopic effect of this is to give to the retinal vessels the appearance of being broken off at the margin of the papilla (Fig. 83), where they

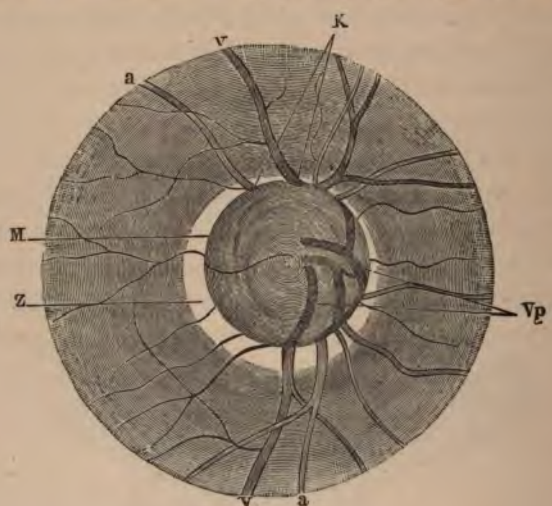


FIG. 83. (*Ed. Jaeger.*)

a. Arteries ; v. Veins ; K. Bending of vessels at margin of the papilla ; vp. Vessels on the floor of the excavation ; z. Glaucomatous ring.

pass round the overhanging edge of the excavation and become hidden by it. On the floor of the excavation they again reappear. The presence of an excavation may be recognized in examination by the indirect method by lateral motions of the convex lens, when, while the whole fundus seems to move in a direction corresponding to the motion of the lens, the floor of the excavation moves

in the same direction but at a much slower rate. This parallax is the more marked the deeper the excavation.

The depth of the excavation may be estimated by examination in the upright image by aid of Landolt's Table given in Chapter II. Besides being cupped the optic papilla becomes atrophied from the pressure.

Around the margin of the glaucomatous excavation, especially in chronic simple glaucoma, one usually sees the whitish appearance termed the glaucomatous ring (Fig. 83), which is said to be due to atrophy of the choroid from pressure.

In glaucoma the functions of the eye suffer from the high pressure, and the following symptoms are produced:

XI. Subjective appearances of light and colour, and coloured halos around lamps and candles are complained of.

XII. The field of vision becomes contracted, in consequence of interruption to the conduction of the retinal nerve-fibres from pressure on them at the margin of the depressed optic papilla. This contraction of the field commences at the nasal side as a rule, while at the same time central vision is lowered, and later on the temporal portion of the field becomes contracted, and gradually absolute blindness is brought about.

All the foregoing symptoms are not found in every case of glaucoma, their presence depending on the rapidity with which the intraocular tension increases.

We distinguish three chief forms of glaucoma:—
1. Acute G. (or Acute Inflammatory G.); 2. Subacute G. (or Subacute Inflammatory G., or Chronic Inflammatory G.); 3. Simple G. (or Chronic Simple G., or Chronic Non-Inflammatory G.).

Acute Glaucoma. When the term "inflammatory" is applied to this and to the second above enumerated form of glaucoma, it is referred rather to the symptoms of the affection than to its pathology.

In acute glaucoma we recognize certain premonitory symptoms, viz.:—Sudden diminution of the amplitude of accommodation, evidenced by the onset or increase of presbyopia and consequent necessity for higher + glasses; and the occasional appearance of coloured halos around the flames of lamps or candles, with attacks of fogginess of the general vision. The duration of one of these foggy attacks may be from a few minutes to several hours. Such attacks are apt to occur after a sleepless night, or after a meal, and are sometimes accompanied with peri-orbital pains. Slight opacity of the aqueous humour and sluggishness of the pupil with some dilatation are present during the attacks. After an attack the eye returns to its normal condition and remains so for some weeks or months, until another similar attack comes on. Such a premonitory stage may last a year or longer, but cases also occur in which there is no premonitory stage.

The onset of the true glaucomatous attack is usually at night. It is accompanied with violent pain radiating through the head from the eye, pericorneal injection, chemosis, and epiphora. The aqueous humour is cloudy, the anterior chamber shallow, the iris discoloured, and the pupil dilated to medium size and of oval shape, the cornea "steamy" and anæsthetic. The patient frequently complains of subjective sensations of light, and vision is very defective, or may be quite wanting. Vomiting very frequently accompanies acute glaucoma, and has often led

to errors of diagnosis, the patient's ailment being taken to be stomachic, while the ocular symptoms were regarded as accidental coincidences, as "a cold in the eye," "neuralgia," etc.

Even such an attack as that just described may, to a great extent, pass away in the course of a few days, but a complete remission of all the symptoms does not come about. Some defect of central vision is left, or, it may be, some slight peripheral defect in the field of vision, the tension does not become quite normal again, and the pupillary motions remain slightly sluggish. Another acute attack of glaucoma comes on in the course of some weeks or months, and it, too, may pass away, but leaving the eye in a still worse condition than it found it. The attacks then become more frequent, and if in the intervals the interior of the eye be examined, the cornea and vitreous humour will be found opaque, the optic papilla cupped, and an arterial pulsation may be discovered. At last there is no remission from the attack, the violent glaucomatous symptoms become permanent, and all vision is for ever destroyed.

Even after vision is destroyed the high tension continues, and goes on to produce disorganisation of the tissues of the eyeball. The iris becomes atrophied, the lens opaque, and the cornea frequently undergoes ulceration, while hæmorrhages are apt to occur in the anterior chamber. The excessive intraocular tension causes staphylomatous bulging of the sclerotic in the ciliary region or further back; and, finally, such eyes may become the subjects of acute purulent choroiditis and end in phthisis bulbi.

Glaucoma Fulminans is the name given by v. Graefe to a form of the disease which is more acute than the ordinary acute glaucoma just described. It has no premonitory stage, and, coming on with all the symptoms of acute glaucoma greatly exaggerated, does not remit, and causes complete permanent destruction of vision in the course of a few hours. It is a rare form.

Subacute Glaucoma. This form differs from acute glaucoma in that its premonitory stage merges gradually into the actual disease without the occurrence of an acute attack. The eye gradually becomes hard, the pupil dilated, the anterior chamber shallow, the aqueous humour opaque, while the cornea is "steamy" and anæsthetic, and the episcleral veins are distended. Ophthalmoscopically, the cupped disc and pulsating arteries may be seen, where the opacities of the media permit. Vision sinks, and the field is contracted towards its nasal side. The progress of the disease is very slow, and in its course attacks of ciliary neuralgia with greater increase of the tension, greater opacity of the aqueous humour, increase of the corneal opacity and anæsthesia, and further dimness of vision are experienced.

These attacks pass off again in the course of a few days or hours, leaving the eye harder and blinder than before. The subacute glaucoma sometimes takes on the acute form. It is liable to bring about the same glaucomatous degeneration of the eye as the latter.

Chronic Simple Glaucoma. In this form there are none of the so-called inflammatory symptoms, no pain, tearing, congestion of the anterior ciliary veins, opacity of the media, discolouration of the iris, or dilatation

of the pupil. In short, in most cases, and especially in their early stages, there is nothing abnormal to be seen exteriorly on the eye. The fundus can readily be examined, and marked cupping of the papilla is found, with arterial pulsation, or, in case the latter be absent, it can easily be produced by slight pressure on the eyeball.

It is a remarkable circumstance, that, in chronic simple glaucoma, the intraocular tension in many cases is little or not at all raised above the normal standard.

The progress of the disease is extremely slow, extending often over several years, and is indicated by gradual failure of central vision, and contraction of the field of vision, chiefly at the nasal side. The disease usually attacks both eyes, but generally one of them long before its fellow. Sometimes chronic simple glaucoma takes on the acute or the subacute form.

Etiology of Glaucoma. Glaucoma is a disease of advanced life, most usually after fifty years of age, and rarely under the thirtieth year. It is not peculiar or more common to any one constitution or temperament. Anxiety, sorrow, and influences in general which depress the spirits, have often been noticed to precede the onset of acute glaucoma.

Von Graefe * believed that a serous choroiditis lay at the root of the disease, which he thought was caused by exudation of serous fluid into the vitreous humour, while Donders,† v. Hippel and Grünhagen‡ and others held that irritation of the fifth pair of nerves, governing

* *Archiv f. Ophthal.* XV. iii. p. 108, and elsewhere.

† *Arch. f. Ophthal.* IX. ii. p. 215.

‡ *Arch. f. Ophthal.* XIV. iii., XV. i. and XVI. i.

the secretion of the intraocular fluids, gave rise to hypersecretion of those fluids.

Others again held, that changes in the sclerotic, rendering it rigid, and leading to some shrinking of it, caused the increased intraocular tension.

Laqueur* believes that some such sclerotic changes produce obstruction of the posterior ways of exit of the intraocular lymphatics, namely, those which pass out with the four vasæ vorticosæ, and that glaucoma depends largely upon this obstruction.

The theory, however, most generally held in the present day, is that which owes its origin to Max Knies† and Adolf Weber,‡ who ascertained that, in glaucomatous eyes, the periphery of the iris lies in contact with the periphery of the cornea in the region of the canal of Schlemm and ligamentum pectinatum. This region and these tissues had previously been proved by Leber§ to be the ways of exit of the effete intraocular fluids, and Weber and Knies concluded, that a blocking of these passages by the close application of the iris caused glaucoma; thus rendering the disease one of retention rather than of hypersecretion. Weber believes that swelling of the ciliary processes from one cause or another pushes the periphery of the iris forwards, and gives the starting point for glaucoma. Brailey,‖ to a certain extent, adopts this view of Weber, but regards¶ a chronic inflammation of the ciliary processes

* *Von Graefe's Archiv*, Vol. XXVI. ii.

† *A. v. Graefe's Archiv*, XXII. iii. p. 163, and XXIII. ii. p. 62.

‡ *A. v. Graefe's Archiv*, XXIII. i. p. 1.

§ *A. v. Graefe's Archiv*, XIX. ii. pp. 87–185.

‖ *Ophth. Hosp. Rep.* X. p. 282.

¶ *Ophth. Hosp. Rep.* IX. p. 199, and X. pp. 14, 89, 93.

and periphery of the iris, with distension of the blood-vessels of these parts, as the chief factor in the earliest history of the disease. Priestly Smith * holds, that the onset of glaucoma is due to diminution or obliteration of the interval existing between the margin of the crystalline lens and the ciliary processes, by reason of progressive increase in the size of the lens, which he has very ably shown† to occur as life advances.

Mauthner‡ holds views with regard to glaucoma which differ widely from those of other writers. Like v. Graefe, he looks upon glaucoma as a choroiditis, but unlike him, he regards the increase of tension not as an essential of the disease, but as merely accidental. He regards the cupping of the optic papilla as an ocular deception, due to a diseased diaphanous condition of the optic nerve fibres, accompanied with retraction or sinking back of the lamina cribrosa, both being the result of a diseased process propagated from the choroid. The closure of the angle of the anterior chamber he believes to be the result, not the cause of glaucoma.

Treatment. The performance of an iridectomy is the means discovered by v. Graefe,§ in 1857, for the cure of glaucoma, a disease which until then had been incurable. This treatment has until lately held an undisputed position as the sovereign remedy for the disease, and, even yet, has suffered but little from the competition of the proceeding termed sclerotomy.

* On Glaucoma, 1879. *Ophthal. Hosp. Rep.* Vol. X. and *Trans. Internat. Med. Congress*, 1881.

† *Trans. Ophthal. Soc. United Kingdom*, Vol. III. p. 79.

‡ Die Lehre vom Glaucom. Wiesbaden, 1882.

§ *Archiv f. Ophthal.* III. ii. pp. 456–555.

To ensure the success of the operation, so far as possible, it is necessary :—1. That the incision should be peripheral; *i.e.*, so far back in the corneo-sclerotic margin as is compatible with the introduction of the knife into the anterior chamber and the avoidance of injury to the ciliary body. 2. That the portion of iris removed should be wide, *i.e.*, involving about one-fifth of the entire circumference of the iris.

It is also important to withdraw the knife slowly from the anterior chamber, when the corneo-sclerotic section is complete, in order that the aqueous humour may flow off slowly, and the occurrence of an intraocular hæmorrhage from the sudden reduction of tension be avoided. The portion of iris should be most carefully abscised, so that no tag of it may remain in the wound, and become caught in the cicatrix in the course of healing. Such an occurrence is very apt to produce a cystoid cicatrix, which may at a later period give rise to irritation and even serious inflammation. Some operators prefer Graefe's cataract knife for the performance of the operation, but the ordinary lance-shaped iridectomy knife is the instrument usually employed. For the purpose of reducing the intraocular tension, it matters nothing what region of the iris is abscised; as a rule, however, the upper quadrant is to be preferred, for there the resulting coloboma will give rise to less diffusion of light than in any other position.

Immediately after the operation, palpation of the eyeball should show a marked diminution of tension. When this is not so, the prognosis is unfavourable. Should an increase of tension occur on the day after the operation it is of no consequence, as it passes off again in the

course of the next few succeeding days. Until then the anterior chamber will not be restored, and I have seen cases where the anterior chamber did not appear for a week or more. The bandage should be worn until the anterior chamber is completely restored, and for that time also eserine should be instilled night and morning. Von Graefe recommended that when, immediately after the iridectomy, the intraocular tension continued high, no bandage should be applied, as he believed it to do harm, but advised that the eyelids should simply be kept closed with a strip of court plaster. The pain after the operation is considerable, but may be relieved with a hypodermic injection of morphia in the corresponding temple.

As a rule, the more acute the form of glaucoma and the earlier in the disease the iridectomy is performed, the more favourable is the prognosis in respect of the result which may be hoped for. The saving of normal vision can only be looked for in those cases, chiefly of the acute form, where it has as yet fallen little or not at all below the normal, and where the contraction of the field has barely commenced. When the disease has interfered seriously with vision (of course I do not refer here to the enormous loss of sight immediately attendant upon an attack of acute glaucoma), we should not expect more than the retention of the *status in quo*. But our prognosis, even in this respect, should be most guarded, especially in chronic simple glaucoma, when the contraction of the field is found to have approached close to the fixation point, although central vision may be fairly good. For, in such cases, while the iridectomy proves successful so far as reduction of tension is concerned, yet the

contraction of the field, *i.e.*, the progress of the atrophy of the optic nerve, is often not arrested, and shortly afterwards may be found to engulf the centre of vision. The result obtained from iridectomy in acute and subacute glaucoma, on the bases just laid down, may be regarded as amongst the most satisfactory in the whole range of ophthalmology. In chronic simple glaucoma iridectomy does not act with the same degree of success, and the prognosis should therefore be more guarded in these cases.

In cases of acute or subacute glaucoma it has frequently been observed, that shortly, even within a few hours, after the performance of the iridectomy the other eye, previously healthy, or at most affected with but slight premonitory symptoms, is attacked with glaucoma. Laqueur thinks this is due to dilatation of the pupil, *i.e.*, crowding of the iris into the angle of the anterior chamber, in consequence of confinement in the dark room.

It may here be stated, that the use of atropine in an eye with a tendency to glaucoma is liable to bring on an acute attack of the disease, and must be carefully avoided in such cases.

If the tension be not relieved by the iridectomy, a supplemental iridectomy may be performed after a time, and v. Graefe recommended that it should be placed at the opposite side of the pupil from the first coloboma.

The Mode of Action of the Operation is not clearly known. Von Graefe at one time believed it to act by diminution of the secreting surface of the intraocular fluids. De Wecker* and Stellwag,† even previously to the

* *Bericht der Ophthal. Gesellsch. zu Heidelberg*, 1869.

† Der Intraoculare Druck, etc. Vienna, 1868.

formulation by Knies and Weber of the retention theory of glaucoma already referred to, held that the cure depended, not on the removal of the portion of iris, but on the incision in the corneo-sclerotic margin, or rather on the nature of the cicatrix resulting from the incision. They maintained that this cicatrix was formed of tissue, which admitted of a certain amount of filtration through it of the intraocular fluids, and that in this way the intraocular tension was kept down to the normal standard. This theory has gained support from that of Knies and Weber.

Holding this view, these authors* and Quaglino† sought to produce the corneo-sclerotic cicatrix without the removal of a portion of iris. The peripheral position of the wound, however, rendered the proceeding difficult or impossible, owing to the tendency to prolapse of the iris which necessarily existed. The introduction of eserine at last enabled de Wecker to place the operation on a surer footing, as the myosis produced by instillation of a solution of this drug into the eye ensured the operator to a great extent against the danger of prolapse of the iris, and hence

Sclerotomy has come to be cultivated as a method for the relief of glaucoma, and has proved useful as such. It has hitherto been employed more in chronic simple glaucoma, a form in which, as stated, iridectomy is less satisfactory than in acute or subacute glaucoma. Care must be taken that the pupil is contracted to pinhole size

* *Bericht der Ophthal. Gesellsch. zu Heidelberg,* 1871. Chirurgie Oculaire, p. 212. Paris, 1879.

† *Annali di Ophthalmologia,* I. 2, p. 200, 1871.

or nearly so, when the operation is about to be performed, as otherwise the danger of prolapse of the iris is very great. In those cases where eserine will not produce a sufficient myosis, sclerotomy should not be performed.

The instrument used for performing the operation is v. Graefe's cataract knife. A speculum having been applied and the eyeball fixed, the point of the knife is entered into the anterior chamber through the corneo-sclerotic margin at a point of its circumference correspanding to that selected for the puncture in cataract extraction, but 1 mm. removed from the corneal margin, as represented at *a* in Fig. 84. The counter-puncture is made at a point corresponding to this at the other side of the anterior chamber, at *b*. With a sawing motion of the knife the section is enlarged upwards, until only a bridge of tissue about 2 mm. broad* remains at *c*, and this is left undivided, the better to guard against prolapse of the iris. The knife is now slowly withdrawn from the eye, care having been first taken that the aqueous humour is thoroughly evacuated, which can be effected by tilting the edge of the knife slightly forwards, so as to make the lips of the wound gape somewhat. If the pupil be quite round at the conclusion of the operation, the bandage may be applied, a drop of solution of eserine having been first instilled. But if the pupil be oval, or of other irregular shape, a tendency to prolapse of the iris is indicated, and the hard rubber or silver spatula should

FIG. 84.

* Too narrow in figure.

be introduced into the anterior chamber, to restore the pupil to its normal shape by gentle pushing of the iris. If there be an actual prolapse of the iris, an attempt may be made to repose it with the spatula; but, should this not prove satisfactory, the prolapse should be abscised with scissors, thus turning the sclerotomy into an iridectomy.

The Treatment of Glaucoma by Eserine can be adopted to a limited degree. A small percentage of cases of acute glaucoma may be radically cured by a few instillations of a solution of the drug. But the great use of the application will be found in cases of acute glaucoma, where it is desirable to postpone operation for a few days, and in cases of chronic simple glaucoma, where it may be desired, if possible, to avoid any operative interference. In the latter cases the daily instillation of eserine for many months may be employed, the eye being watched carefully. But a radical cure by operation should always be urged upon the patient.

SECONDARY GLAUCOMA.

In addition to the different forms of primary glaucoma above described, we find glaucomatous tension occurring as a sequence of diseased conditions already existing in the eye. Some of these latter are :—intraocular tumours, staphyloma of the cornea, staphyloma of the sclerotic, swelling of an injured crystalline lens, dislocation of the lens, serous iritis, complete posterior or ring synechiæ. Iridectomy, sclerotomy, or even puncture of the anterior chamber may be employed, according to the special indi-

cations of the case, with fairly satisfactory results in these forms of secondary glaucoma. Another and very peculiar form of secondary glaucoma is :—

Hæmorrhagic Glaucoma. Retinal hæmorrhages of the ordinary type are sometimes followed a few weeks later by increased intraocular tension, which generally assumes the symptoms of acute or subacute glaucoma, and more rarely those of chronic simple glaucoma. When such a glaucoma has become pronounced, it is not usually possible to distinguish it from a primary form of the disease. Iridectomy in these cases is more likely to do harm than good, the operation being almost invariably followed by fresh intraocular hæmorrhages and a further increase of tension. Sclerotomy is said by some to act with fairly good results in hæmorrhagic glaucoma.

HYDROPHTHALMUS CONGENITUS,

Also known as Buphthalmus and Cornea Globosa, is a disease of early childhood, of which the incipient stages are believed to be intra-uterine. The cornea becomes enormously enlarged in diameter, the anterior chamber deep, the iris trembling, and the sclerotic thinned. Increase of tension and cupping of the optic papilla are usually present, and the disease is regarded as a secondary glaucoma, although it is by no means certain that it should not rather be considered as a form of primary glaucoma occurring in young children. Iridectomy and sclerotomy are alike followed by disastrous results in this disease. It is incurable.

CHAPTER XVI.

DISEASES OF THE CRYSTALLINE LENS.

Cataract, which means partial or complete opacity of the lens, may be said to be its only disease. Of it we recognise several varieties.

Senile Cataract occurs in persons over forty-five years of age. It commences in the centre or so-called nucleus of the lens as a diffused opacity; or, at the equator in the cortical layers as fine grey striæ; or, it may appear almost simultaneously in each situation; and again, the opacity may be more disseminated through the cortex, in the form of flocculi, dots, and lines. Gradually the opacity invades other portions of the lens, until finally the whole has became opaque, and then the cataract is said to be ripe.

The length of time occupied by this process varies greatly in different cases, from a few months to many years. In the very old the progress is, in general, more rapid than at an earlier time of life. That form which commences in the periphery as fine lines is slower than that with flocculent opacities, or than that in which the nucleus is likewise implicated at an early period.

In senile cataract the nucleus of the lens can usually be recognised by the yellowish reflection obtainable from it.

Förster, indeed, is of opinion, that senile cataract commences with an abnormal differentiation into a clear yellow nucleus and a clear colourless cortical layer.

Otto Becker * has shown that the formation of spaces and clefts between the lenticular fibres always precedes the occurrence of true opacity. These interspaces are filled with a clear fluid, the same, namely, which exists in the normal lens and in all other living tissues. When these clefts make their appearance in the anterior or posterior cortical layers, they may be seen with the ophthalmoscope as dark lines, which vanish and reappear as the incidence of the light thrown on them is varied.

The investigations of Priestly Smith † have shown, that a diminished rate of growth of the lens precedes the formation of cataract; and it is probable, that an excess in the process of physiological degeneration causes the peripheral layers to separate from each other, enabling the fluid to collect in the interspaces; and the stagnant fluid in its turn produces disturbances of nutrition in the fibres, of which opacity is the evidence. Later on the various layers of the lens become dislocated, the fibres, especially those of the cortical substance, become broken up into a molecular mass, and calcareous and fatty deposits are formed.

The cause for these lenticular changes has not been clearly made out. Deutschmann ‡ detected albumen in the urine in one-third of the cases examined by him, and inferred that renal disease is a frequent cause of cataract,

* Zur Anatomie der Gesunden und Kranken Linse, 1883.

† *Trans. Ophthal. Soc.*, 1883, p. 79.

‡ *A. v. Graefe's Archiv*, Vol. XXIII. part iii. p. 112.

while Michel* has asserted that senile cataract is a result of atheroma of the carotid, and consequent interference with the blood-stream to the eye and the supply of nutrient fluid to the lens. De Wecker does not accept either of these theories in their entirety. Chronic nephritis is usually associated with changes in the walls of the small arteries and capillaries, and, when the carotid is the seat of considerable atheroma, it is likely that the vessels of the uveal tract, although the ophthalmoscope may not reveal it, are similarly affected. It may be, then, that degeneration of the intraocular blood-vessels is the missing link between nephritis and disease of the carotid on the one hand, and cataract on the other.

Symptoms and Signs. The degree of disturbance of vision caused by cataract depends on the position of the opacity, and on the stage of its progress. Striated opacities in the periphery of the lens give rise to little or no visual trouble; while a comparatively slight opacity in the nucleus incapacitates the patient for many pursuits, and this difficulty is increased in bright light owing to contraction of the pupil. In the earliest stages the patients complain of fogginess of the atmosphere, floating spots before the eye, distortion of objects, and polyopia when very distant objects are looked at, one or more of these appearances being present in each case. With mature cataract vision is reduced to the counting of fingers at a few feet, or even to mere perception of light.

The actual presence of lenticular opacity is to be ascertained by aid of the ophthalmoscope and focal

* F. Horner's Festgabe (Ophthal. Beiträge), 1881.

illumination. Those opacities which are situated in the periphery of the lens in incipient cataract can be seen by the transmitted light from the mirror as black pointed striæ. Too strong light should not be employed in the examination, so that the pupil be not too much contracted, and in order that the rays may be reflected back from the opacities as completely as possible, which will enable them to be more easily seen. A commencing nuclear opacity may often be recognised in the same way, especially if the pupil be dilated, but focal illumination of the lens is more advantageous. Both methods, however, should be combined.

Care must be taken not to confound a highly sclerosed senile lens for cataract. The former affords a smoky or mother-of-pearl reflection on focal illumination, which is often very deceptive, but with the transmitted light the lens is seen to be perfectly clear, and the vision will be found normal, unless other causes for blindness be present.

In advanced stages of the disease the opacities occupying a great portion of, or the entire lens, are easily recognised even by ordinary daylight, often giving a greyish appearance to the pupil. Inflammatory exudation in the area of the pupil would afford a somewhat similar appearance, but would be attended by other signs of the previous inflammatory process, such as synechiæ, disorganisation of the iris, etc.

All examinations as to the condition of the lens are rendered easier and more conclusive if the pupil be previously dilated with atropine. The tension of the eye should be ascertained before atropine is instilled, lest glaucoma be present.

The Consistency of Senile Cataract varies much, and it is of some importance, in view of operative measures, to decide whether a cataract be hard or soft. The larger the nucleus and the finer the striæ in the cortical substance, the harder is the cataract. Soft cataracts have small nuclei and broad glistening striæ, are often pale grey in colour and somewhat swollen, so as to push forward the iris and render the anterior chamber shallow. In some old cataracts which have undergone degeneration the cortical portion becomes fluid, and the nucleus gravitates to the most dependent part of the capsule, where, so long as the capsule remains tolerably normal, it may be seen by its yellowish reflection. This is termed Morgagnian cataract.

In some cases the pupil maintains its blackness, owing to the very dark colour of the lens. This is the so called black cataract, which, although causing great impairment of vision and requiring operation, is not really a cataractous condition, but an exaggerated example of the physical changes which the lens undergoes with advancing age; namely, a drying up and hardening, and a yellowish or tawny discoloration.

The Ripeness of a Senile Cataract. By this is meant a condition in which the whole lens substance can be removed by operation (Förster). In a majority of the cases it coincides with complete opacity of the lens. The existence, or otherwise, of this latter condition is ascertained by examining, with focal light, the cortical portion of the lens. If this be not opaque up to the inner surface of the capsule, a clear interval will be present between the iris and the nucleus, a shadow of the iris will be thrown

on the nucleus at the side from which the light comes, and the cataract is proved to be immature. If the whole cortical substance be opaque, the thickness of the capsule alone will intervene between the pupillary margin and the opacity. In addition to this examination with the focal light, the pupil should be dilated and the lens examined by transmitted light from the ophthalmoscopic mirror, when a completely opaque cataract should permit of no red reflection being obtained in any direction from the fundus oculi.

Förster * points out that complete opacity does not always indicate maturity, for in some ripe cataracts the iris shadow and red fundus-reflection may still be obtained, while in some unripe cataracts neither can be seen. According to this author cataracts which may be regarded as ripe are :—

1. The great majority of cataracts which appear ripe according to the two ordinary tests already named, and in which there are no sectors shining like mother-of-pearl. Such cataracts are white, yellow, or yellowish-grey; the whiter they are, the thicker the cortical substance.

2. Cataracts in which the lens consists wholly of a large brownish-yellow nucleus, no cortex being discoverable, or at most only a very thin layer. Such cataracts may show a considerable degree of semi-transparency, the pupil being more or less illuminable, and the iris throwing a distinct shadow. They also allow a considerable amount of vision. The only alteration which they undergo is that their brown colour becomes darker with time.

* *Archives of Ophthalmology*, Vol. XI. 1882, p. 344.

3. Certain cataracts, of very slow development, with bright yellow or whitish and relatively small nuclei, and a thick layer of semi-transparent cortex (Becker's Nuclear Cataract). In the course of years a thin subcapsular layer grows opaque, but much of the cortex may remain clear, and the iris still cast a shadow; the anterior surface does not exhibit sectors, and does not glitter like mother-of-pearl. In this stage these cataracts escape from the capsule without leaving any cortical fragments.

A cataract is immature, despite the absence of shadow from the iris and the illuminable pupil, if the cortex presents well-marked glittering sectors. The glitter of the different sectors varies with the angle of illumination, so that the surface appears faceted. Here there are thin transparent flakes as well as opaque flakes close beneath the capsule, and, if extraction be undertaken, the former will almost certainly remain within the eye in spite of every effort to remove them. A few months later the sectors lose their sharp contour, break down, and finally disappear. We can then depend upon the exit of the whole cataract.

The reason of the *importance of determining the maturity of a cataract* is, that if its removal be attempted prior to that period, morsels of the cortical substance adhering to the capsule remain behind, and, being clear, are not noticed at the time of the operation, but, having meanwhile become opaque, they appear next day as grey masses filling up the pupil, and liable to produce disagreeable inflammatory reaction (*vide infra*).

Treatment. No external local applications nor internal

medicines are of any avail in the treatment of cataract at any stage. Removal of the cataract from the eye by operation when it has reached maturity is its ultimate destiny, if the patient live to that period.

The question whether when a patient first consults a surgeon for defect of sight due to commencing cataract, it is expedient to inform him of the nature of his disease, is a difficult one. Inasmuch as it is impossible to form any idea of the length of time which may elapse before the cataract will have become ripe, and as a long period of useful vision may intervene between this first visit and really impaired sight interfering with the usual avocations, it is as a rule better not to give the patient definite information concerning the state of his eye. The opposite mode of action entails in very many cases a long period of anxiety for the patient without any counterbalancing advantage; for it cannot be conceived how anxious some people become when informed that they have cataract. Of course the danger of this line of conduct is that the surgeon may be blamed for ignorance or for want of candour, and doubtless each case must be dealt with for itself. The late Mr. Critchett,* in cases of incipient lenticular opacity, abstained as much as possible from using the word cataract, which carries with it so indescribable a horror to the minds of many.

In cases of incipient cataract, or in those, rather, which have advanced somewhat beyond this stage, we often find that vision is improved or made more pleasant by the wearing of tinted glasses to moderate the light. With commencing cataract an emmetropic eye is liable

* *Ophthalmic Review*, Vol. I. p. 24.

to become slightly myopic, and then low concave glasses for distant vision will be found of service. For reading, stenopæic glasses often give good results. Dilatation of the pupil with atropine is in many cases of the greatest benefit, especially where the nucleus is much more opaque than the cortical portion; but sometimes the diffusion of light resulting is most distressing to the patient, and greater impairment and confusion of vision is produced, and for this reason care in the prescription of atropine is demanded. Patients with incipient or advancing cataract may be allowed to enjoy the sight they possess with immunity, and the surgeon should give them hints as to the arrangement of light in their rooms, for their work, etc., to enable them to use their eyes to the best advantage.

The truly distressing period in the progress of cataract, when both eyes are affected, is that between the advent of such blindness as incapacitates the patient for reading or writing or making his own way about, and the occurrence of complete maturity. This is often a lengthened time, it may be months or years. Fortunately in many instances one cataract becomes ripe while that in the other eye still admits of fair vision, and then no such trial may have to be gone through.

In order to hasten the maturity of a cataract, puncture of its anterior capsule has been proposed and practised with success; but has not been generally adopted, from the dread that it might set up iritis, and produce increased tension from excessive swelling of the cataract. Förster* effects artificial ripening by performing an

* *Archives of Ophthalmology*, Vol. XI. No. 3, p. 349.

iridectomy, which can afterwards be utilized for the extraction. This in itself often expedites the ripening, probably by disturbing the arrangement of the lens fibres when the aqueous humour flows off, and Förster promotes the disturbance by gently rubbing or stroking the cornea immediately after the iridectomy with the blunt angle of a strabismus hook. Soon after this a rapid increase in the opacity is often noticed, so that in from four to eight weeks extraction can be undertaken. The difficulty lies in the calculation of the pressure to be applied; for, if this be excessive, the zonula may easily be ruptured, with the result of loss of vitreous when the extraction comes to be performed. The best results are obtained in cases of cataract with a firm and somewhat opaque nucleus, and where a certain amount of opacity already exists in the anterior cortical substance. Some operators have seen iritis to follow on the use of this method.

The question, whether one eye should be operated on until both are blind, is often asked by patients, as formerly it was not the practice to do so. A patient with one mature cataract and the other progressing towards maturity should have the ripe cataract removed. Hypermaturity is thus avoided, and also the stage of blindness above referred to. If there be a ripe cataract in one eye and not even incipient cataract in the other, it is unadvisable, as a rule, to operate; for the eyes would be of such different refraction, that they could not be used together, and the patients would often be more confused than assisted by the degree of sight given to the operated eye.

Complete Cataract of Young People. The spon-

taneous occurrence of total cataract in the youthful lens is of rare occurrence, and its pathogenesis still unknown.

Treatment: Discission.

Diabetic Cataract. This is a complete opacity of the crystalline lens occurring in diabetes and due to the disturbed nutrition. The cataract does not differ in appearance or consistency from other cataracts according to the time of life of the patient.

Treatment: The cases are favourable for extraction operations.

Complete Congenital Cataract. Children are sometimes born with crystalline lenses opaque in all their layers, while the other tissues of the eye are healthy. With congenital cataract defects of the choroid or retina are also sometimes present, and these are usually indicated by nystagmus.

Treatment: Discission.

Central Lental Cataract. This is a congenital and usually non-progressive form. It is an opacity of the central or oldest lens fibres, while the peripheral layers remain clear.

Treatment: Discission, or iridectomy.

Zonular or **Lamellar Cataract.** This is congenital, or forms in early infancy. In it the very centre of the lens is clear (Fig. 85), while around this is a cataractous layer or zone, and outside that again the peripheral layers are quite transparent. Most of these cases are non-progressive, but occasionally the whole lens does become opaque, and usually then there have been previously some slight opacities in the otherwise clear cortical layers.

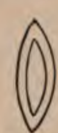


FIG. 85.

T

Treatment: Discission, or iridectomy.

Posterior Polar Cataract is a congenital circumscribed opacity at the posterior pole of the lens. It rarely demands *treatment*, but if any be called for, discission of the lens is probably the most suitable measure.

Fusiform or **Spindle-Shaped Cataract** is also congenital, and is rare. It consists in an axial opacity extending from pole to pole, and may be combined with central or lamellar opacity.

The Pathogenesis of the foregoing congenital cataracts, consists, probably, in some intra-uterine disturbance of nutrition, their various forms depending upon the length of duration of this disturbance, and possibly also upon the period at which it takes place. Horner first put forward the theory, that such an intra-uterine disturbance, occurring while the lens is in process of formation, causes an opacity of the newest layers, but passes off again before the older central layers have become affected, while the succeeding layers are formed under restored normal influences, and that in this way zonular cataract comes about. This theory has gained strong support from an experiment of Leber.* Mr. Hutchinson has pointed out the frequent association of lamellar cataract with imperfect development of the enamel of the teeth.

The Treatment of central lental cataract and of zonular cataract is similar, and consists in either discission or iridectomy. The latter is very decidedly to be preferred in those cases in which the central opacity is small, so that, on dilatation of the pupil, the acuteness of vision, with the aid of a stenopæic slit, is increased in a satis-

* *A. v. Graefe's Archiv*, Vol. XXVI. i. p. 283.

factory degree. When the improvement is but slight, the breaking up of the lens is indicated. The advantage of iridectomy over discission, when the former can be adopted, is, that no spectacles are afterwards required, and that the power of accommodation is retained.

Anterior Polar or **Pyramidal Cataract** either congenital or acquired. In the former case it must be referred to some inflammatory disturbance about the third period of development of the lens. In both cases the mode of origin of the opacity is the same, whether it be punctiform, flake-like, or pyramidal, namely, by contact of the lens with an inflamed cornea. In fœtal life this may occur without any perforation of the cornea, as there is then no anterior chamber. After birth a perforating ulcer of the cornea is a necessary precursor of it, but the ulcer need not be central (p. 102). This contact with an inflamed and ulcerating cornea may lead to subcapsular cell-proliferation at that portion of the capsule which is exposed in the pupillary area. No treatment is required, as vision is not affected.

Total Secondary Cataract often ensues upon contact of the lens with the vascular tissues of the eye (Becker), *e.g.*, where false membranes have been produced by inflammatory processes in the uveal tract, also in detachment of the retina, intraocular tumour, absolute glaucoma, etc. The reason of this is, that the lens imbibes abnormal nutrient fluid from the tissues with which it is in contact. Such cataracts rarely come within the range of treatment, as the diseases which give rise to them are usually destructive of sight. When, occasionally, they can be dealt with, they should be extracted.

Capsular Cataract means an opacity of the anterior capsule, or of the capsular epithelium. It is usually confined to the centre or anterior pole, and is most frequently seen in over-ripe senile cataracts, and in secondary cataracts.

Traumatic Cataract. Cataract results from any injury which opens the capsule of the lens. Those which most commonly cause it are punctured wounds through the cornea; but blows (closed hand, soda-water cork, billiard cue, etc.) on the eye may rupture the capsule, without any wound of the coats of the eyeball. In many of these cases the lens undergoes absorption, as after discission, without causing any unpleasant inflammatory reaction, provided the eye be kept under the influence of atropine, and strong light be excluded. In other cases iritis and secondary glaucoma come on.

Operations for Cataract.

With regard to the *State of Health of the Patient* about to be operated on, it is desirable, as in every operation, that it should be good. Still, we have so often in these cases to deal with very old people, that we cannot in every instance require sound organs and robust constitution; and, as a matter of experience, I have not found serious disease of the heart, lungs, and liver, even when they all existed in the same individual, any impediment to a successful operation. Diabetes is no contra-indication, but Bright's Disease should be such.

The State of the Eye itself should be carefully in-

vestigated prior to proposing or undertaking an operation for cataract. Above all things it should be determined that no intraocular complications are present, which would neutralize the result of a successful operation, such as detachment of the retina, disseminated choroiditis, atrophy of the optic nerve, etc. The examination of the eye in question before the lens has become opaque, if the surgeon have had that opportunity, will be the most reliable basis upon which to go; and, for this reason, a careful note should be taken of the condition of the fundus in each case of incipient cataract. The examination of the fundus of the other eye, if its lens be clear, may help in determining the point, so far as those intraocular diseases are concerned which are apt to be binocular. Again, the condition of the anterior capsule of the lens should be observed, for a defined glistening white square patch, about 2 mm. broad, situated in the centre of the capsule, tells the tale of intraocular mischief. It cannot be confounded with the more diffused striated and punctated capsular alterations due to over-ripeness.

Finally, the functions of the eye should be examined. In an uncomplicated cataract of the most opaque kind good perception of light should be present, so that the light of a candle some two metres distant may be distinguished. In less dense cataracts fingers may be counted at 1 m. or 1·5 m. when full maturity has been attained. The field of vision must be examined by means of the projection of light. A lighted candle held in different parts of the field should be recognised by the patient, who is required to point his finger in the direction of the light, as it is moved rapidly from one part of the field to

another. This examination can also be made by means of the light reflected from the ophthalmoscopic mirror. If the patient fail to project the light in any direction, a diseased condition in the corresponding part of the retina may be suspected. In cases of very old uncomplicated cataract the patients often project the light in some one direction, no matter where it come from.

The subjective sensation of light (phosphene) produced by pressure on the eyeball is also a valuable aid in this diagnosis. The patient being directed to look downwards, the end of a blunt probe is pressed gently on the globe, through the upper eyelid, so that the phosphene may be made to appear in the lower part of the field; if it cannot be produced, a complication in the lower part of the fundus may be suspected. In the same way each part of the fundus can be examined. A certain amount of intelligence on the part of the patient is required for this test.

By the foregoing means most intraocular complications of a serious nature can be detected, but there is at least one against which I know of no safeguard, namely, a small circumscribed spot of choroido-retinal degeneration at the macula lutea (central senile choroiditis). After removal of cataract from an eye affected in this way, the patient's vision is so much improved as to enable him to go about alone, but reading will still remain an impossibility for him.

The Cornea should be examined. Such corneal opacities as would seriously compromise vision may contra-indicate the operation, but slighter opacities, discernible only with oblique illumination, would diminish the future

acuteness of vision, and require a corresponding prognosis to be given.

The Condition of the Appendages of the Eye, too, must be examined, if extraction of cataract be proposed. Should there be any conjunctivitis, blepharitis, or dacruocystitis, it ought to be cured or alleviated before the operation is undertaken. Very successful operations may be performed in the presence of chronic dacruocystitis, or granular ophthalmia, but it is in all respects wiser to reduce their activity to a minimum.

Reclination is a method of treating senile cataract in use many years ago, but now quite abandoned in favour of the safer one of extraction. It consists in passing a needle through the sclerotic and depressing the lens out of the pupillary area into the vitreous humour. If violent inflammatory reaction does not come on soon afterwards, the eye is almost invariably destroyed subsequently by chronic irido-cyclitis.

Extraction of Cataract. Until about twenty years ago the *Flap Extraction* was that most in vogue. The

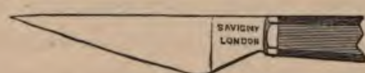


FIG. 86.

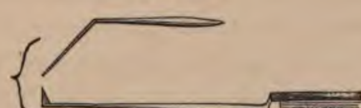


FIG. 87.

instruments required were a Beer's cataract knife (Fig. 86), and a cystotome (Fig. 87). The operation was performed

either in the lower or upper half of the cornea. In the former case (Fig. 88) the point of the knife is entered at, or

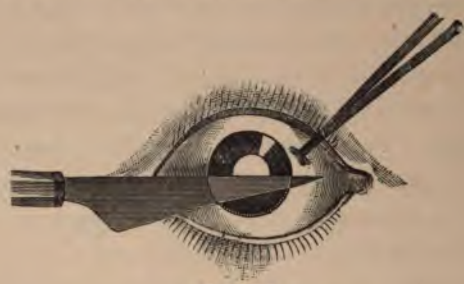


FIG. 88.

1 mm. inside, the outer margin of the cornea and just below its transverse meridian, and the blade, being held in a plane parallel to that of the iris, is carried across the anterior chamber to a point diametrically opposite in the inner corneal margin. By steady advance of the knife it is made to cut its own way out without any to-and-fro motion, and thus a flap is formed of the lower half of the cornea.

The cystotome is then introduced into the anterior chamber, and the capsule opened by a few gentle strokes, care being taken, both in the introduction and removal of the instrument, that the iris be not entangled in it.

The cataract is delivered by directing the patient to look up, while the surgeon gently draws the upper lid upwards and the lower lid downwards. The contraction of the orbital muscles then force the lens out through the pupil. Or, if muscular contraction be not sufficient for the purpose, the surgeon may apply gentle pressure to the globe with the upper lid, while he causes the

wound to gape by pressure on the sclerotic with the lower lid.

The flap extraction was only used for hard senile cataracts. This very elegant operation has fallen into disuse, owing to the many accidents liable to occur in its performance, and the great tendency to suppuration of the wound.

Linear Extraction. The extraction through a linear incision in the cornea is applicable only to soft or fluid cataracts in persons up to the age of twenty-five. The instruments required are:—A spring lid elevator (Fig. 89),

FIG. 89.

a fixation forceps, a wide lance-shaped iridectomy knife (Fig. 90), a cystotome, and a Critchett's spoon (Fig. 91).

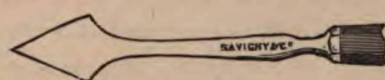


FIG. 90.

The speculum having been applied, a fold of conjunctiva close to the margin of the cornea and at the

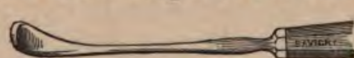


FIG. 91.

inner end of the horizontal meridian of the latter is

seized with the fixation forceps (Fig. 92), and the eye fixed by it throughout the operation. The point of the knife is now entered into the cornea in its horizontal meridian, about 4 mm. from its outer margin, and passed

FIG. 92.

into the anterior chamber. The blade of the knife is then laid in a plane parallel to that of the iris, and pushed on until the corneal incision has attained a length of 6 or 7 mm. The point of the knife being now laid close to the posterior surface of the cornea—in order that no injury may be done to the iris or lens, when the aqueous humour commences to flow off—the instrument is very slowly withdrawn, so that the aqueous humour may come away gradually, without causing prolapse of the iris. In withdrawing the knife it is well to enlarge the inner aspect of one or other end of the wound, by a suitable motion of the instrument in that direction.

The knife being now put aside, the cystotome is passed into the anterior chamber (Fig. 93) as far as the opposite pupillary margin, care being taken, by keeping the sharp point of the instrument directed either up or down, not to entangle it in the wound or in the iris. The point is now turned directly on the anterior capsule, and, by

withdrawing the cystotome towards the corneal incision, an opening in the capsule of the width of the pupil is produced. The cystotome is then removed from the

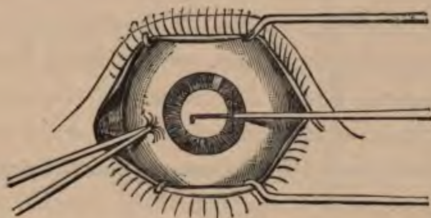


FIG. 93.

anterior chamber, with the same precautions as on its entrance.

The edge of the spoon is then placed on the outer lip of the corneal incision and the latter made to gape somewhat, gentle pressure being at the same time applied to the inner aspect of the eye by the fixation forceps, and in this way the lens is caused to be evacuated. When the pupil has become quite black the operation is concluded. If pressure does not at first clear the pupil completely, the speculum should be removed, the eyelids closed, a compress applied, and a few minutes allowed to elapse, in order that some aqueous humour may be secreted. A renewal of the efforts to clear the pupil will probably now be successful, or, if not, another pause may be made, and then fresh attempts employed until the pupil is quite clear. It is unwise to insert the spoon into the eye to withdraw the fragments, and if some of these should be left behind, no ill results need necessarily follow, although iritis is more apt to supervene than if the lens be

thoroughly evacuated. Fragments left behind become absorbed. If there be a prolapse of the iris which cannot be reposed, it must be abscised.

Von Graefe, Waldau (Schuft), and Critchett endeavoured, by increasing the size of the incision, placing it in the corneo-sclerotic margin, performing an iridectomy, and introducing a spoon for delivery of the cataract, to make the linear extraction applicable to senile cataracts. The successes derived from these modifications were not, however, more satisfactory than those obtained from the old flap operation. But these experiments led von Graefe to the operation which is now very generally employed, and which is called—

The Peripheral Linear Extraction.

The instruments required are:—A wire speculum, a fixation forceps with spring catch, a v. Graefe's cataract knife (Fig. 94), a curved iris forceps, an iris scissors, or a Wecker's forceps-scissors (Fig. 95), a bent cystotome, a hard rubber spoon (Fig. 96), and a hard rubber or tortoise-shell spatula (Fig. 97).

Antiseptic Measures. The conjunctival sac is washed out just before the operation with a 2 per cent. solution of carbolic acid, or with a saturated solution of boracic acid, the instruments are laid in a bath of the carbolic solution until they come into use, and the morsels of lint (not sponges) used to wipe the eye and wound during the operation are kept in the same solution.

Anæsthetics are given for cataract extraction by many operators in England. In Germany they are very rarely

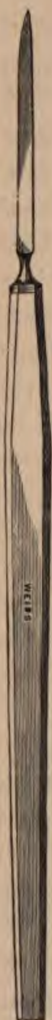


FIG. 94.

FIG. 95.

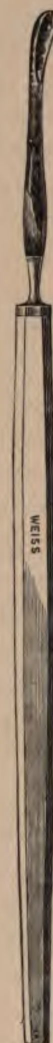


FIG. 96.

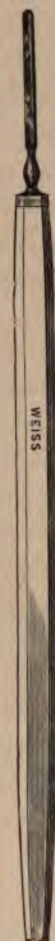


FIG. 97

administered. For my own part I never give them. My reasons for this are:—1. The whole attention of the operator should be concentrated on the operation, and this can hardly be the case if he have the responsibility of watching the effect of the anæsthetic. 2. Chloroform is the only available anæsthetic, for ether is too apt to cause vomiting, but the former is in such disrepute that one dare hardly use it. 3. An anæsthetic is not needed, for the operation is not extremely painful, is not prolonged, and a few encouraging words spoken to the patient during its progress are sufficient to induce him to maintain the necessary quiet. 4. An anæsthetic is positively obstructive to the good performance of a cataract extraction, as all assistance on the part of the patient must be dispensed with. 5. The patient by moving his eyes in the direction desired enables the surgeon to avoid much dragging with the fixation forceps. 6. And finally, when the operation is ended, the testing of the vision is important for the satisfaction both of patient and surgeon, but cannot be gone through if an anæsthetic has been administered.

The Operation. The speculum having been applied, the eye is steadied by seizing a fold of conjunctiva with its subconjunctival tissue close to the lower margin of the cornea and opposite the centre of the latter. The eye is now drawn gently downwards, the patient assisting (if not under an anæsthetic) in the motion. The point of the v. Graefe's knife, its cutting edge being directed upwards, is then entered into the corneo-sclerotic margin at a point (A in Fig. 98) about 1·5 mm. from the outer and upper corneal margin, and 2 mm. below the

level of the tangent which would pass through the highest point of the corneal margin. The blade is held in a plane parallel to that of the iris, and is pushed on into the anterior chamber until its point reaches the point C, some 7 or 8 mm. of the blade being now in the anterior chamber. The handle of the knife is then lowered so that the point of the blade is brought up to B, where it is made to pass out through the corneo-sclerotic margin, this counterpuncture corresponding in position, with reference to the corneal margin, to the point of entrance A. The edge of the knife is now turned slightly forwards, and by one or two sawing motions the incision A B is completed in the corneo-sclerotic margin. The blade still lies under the conjunctiva, which is divided, the edge of the instrument being turned more forwards or even somewhat downwards, as it is not desirable to have too large a conjunctival flap.

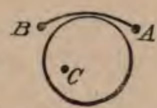


FIG. 98.

The advantage of this incision lies in its peripheral position, which is almost in the plane of the crystalline lens, and consequently enables the cataract to be delivered without revolution on its axis. At a later period v. Graefe altered the incision, so that, puncture and counterpuncture lying as described, the centre of the incision passed through the apex of the clear cornea, instead of through the corneo-sclerotic margin. This, by making the incision more nearly a segment of a greater circle of a sphere, made it as linear as possible, and consequently its margins adapted themselves more readily.

The incision proposed a few years ago by de Wecker, and employed now by many operators, amongst them the author, is generally known by the name of the Three Millimetre Flap.

"The point of the knife is entered at the outer extremity of a horizontal line which would pass 3 mm. below the summit of the cornea. This line is easily found by placing the knife, which is about 2 mm. broad, horizontally across the cornea, so that a margin of clear corneal tissue 1 mm. broad may remain exposed between the knife and the summit of the cornea."* The incision, between puncture and counterpuncture, lies in the clear cornea at its very margin, as represented by the dotted

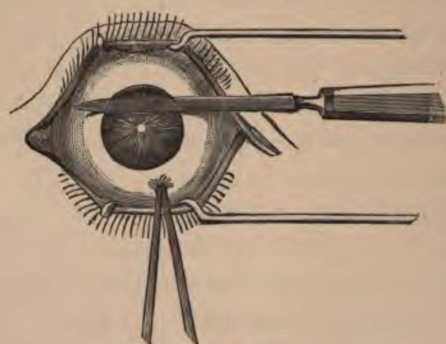


FIG. 99.

line in Fig. 99. This incision is no longer linear, but slightly curved. It is found however to adapt itself readily, and, being less peripheral than the v. Graefe incision, prolapse of the vitreous humour is not so apt to

* Chirurgie Oculaire, L. de Wecker, p. 54.

take place, nor is prolapse of the angles of the coloboma (*vide infra*) so difficult to control.

The second stage of the operation consists in an iridectomy. This, which was not part of the old flap extraction, is necessary or desirable here, because of the peripheral position of the wound, which would make prolapse of the iris very liable to occur; and because the bruising of this part of the iris in delivery of the lens makes it apt to take on inflammation. The fixation of the eye having been given over to the assistant, the iridectomy is performed by passing a curved forceps into the anterior chamber, seizing the iris at a point corresponding with the centre of the incision, drawing it out, and with the forceps-scissors excising a small central bit from it. The excision is done by making two snips in the iris, one at either side of and close to the forceps and reaching to the periphery of the iris, and then a third cut which joins these two at the base. It is quite unnecessary to excise a large portion of iris in the Three Millimetre Flap operation, although in v. Graefe's original operation a portion of iris corresponding with the entire length of the wound used to be taken away. A small coloboma allows of an easy delivery of the lens by doing away with the resistance of the sphincter iridis, and its advantages over a wide iridectomy from optical and æsthetic points of view are obvious. It is, therefore, always my object to obtain the smallest possible coloboma. The procuring of a neat coloboma is much facilitated if, prior to the operation, the pupil has been contracted by the instillation of one or two drops of solution of sulphate of eserine.

The third stage of the operation is the capsulotomy. The operator takes the fixation forceps from his assistant, who then raises the speculum and eyelids slightly off the globe, in order that no pressure may be exerted on the latter during the remainder of the operation. The surgeon, passing the cystotome into the anterior chamber, divides the anterior capsule of the lens by two incisions, each from the lower pupillary margin upwards, one directed outwards the other inwards, as far as the anterior surface of the lens can be seen, while finally a third incision is made along the upper periphery of the lens. An extensive opening in the capsule is of great importance, as otherwise difficulty in delivery of the lens may be experienced, and because a small opening renders the occurrence of secondary cataract more likely. In dividing the capsule it is important not to dig into the lens, as this, in the case of a hard cataract, is apt to dislocate it. A rather oblique application of the cystotome to the capsule is, for this reason, the best.

It should be borne in mind that the cystotome often drags a tag of the capsule into the corneal wound, where it lies until the end of the operation, and where, owing to its transparency, it may easily pass unnoticed. Such a tag acts as a foreign body, and may subsequently form the starting point of severe inflammatory reaction.

Cystotomes, or capsule forceps, have been invented by E. Meyer * and Förster † for the purpose of taking away a large portion of the anterior capsule, a method which seems to have much in its favour, as obviating the danger

* *Handbuch d. Augenheilkunde*, p. 331.

† *Archives of Ophthalmology*, Vol. IX. p. 344.

of capsule in the wound, and as diminishing the likelihood of secondary cataract.

Gayet of Lyons* and Knapp of New York † have proposed a method of opening the capsule termed peripheral division—*i.e.*, they make only one opening in the capsule at the upper periphery of the lens with a very sharp "needle cystotome," which is passed along the whole length of the corneal section, a wide iridectomy having been made for this purpose. The chief advantages claimed for this method are, safety from a tag of capsule in the wound, and safety from iritis caused by irritation from particles of lenticular substance left behind after delivery of the lens. These, however, seem to me to be more than counterbalanced by the disadvantages of the wide iridectomy, and of the secondary operation on the capsule which is necessary in a large proportion of the cases; the more so, as I have not seen iritis in any of my cases for a length of time, unless as the result of too early exposure of the patient to light and weather. The method has not been very extensively adopted.

The fourth stage is delivery of the cataract. The eye is drawn gently downwards, the patient being called on to assist in this motion by looking towards his feet, and the convex edge of the hard rubber spoon is placed just below the lower edge of the cornea, and gentle pressure exercised on this place, the pressure to be gradually increased until the upper margin of the lens presents in the wound, when, the same pressure being maintained, the spoon is advanced over the cornea in an upward direc-

* *Gazette Hebdomadaire*, 1875, No. 35.

† *Archives of Ophthal. and Otology*, Vol. VI. p. 545.

tion, pushing the lens before it and out through the wound. As soon as the greatest diameter of the lens has passed the wound, the pressure of the spoon should at once be diminished, lest rupture of the zonula be caused. The fixation forceps and speculum are now removed from the eye, and a cold compress laid on it.

The fifth stage consists in freeing the pupil of any cortical masses which may have been rubbed off in the passage of the lens through the wound, and in what is called the "toilette" of the wound. The presence of cortical remains is recognized by the pupil not having become quite black, or by the vision not being such as it ought to be (fingers counted at several feet). The use also of the oblique illumination for the detection of cortical fragments is very advantageous. If any fragments be present, the cold compress having lain on the eye for a few minutes to enable some aqueous humour to collect, the operator, facing the patient, raises the upper lid with the thumb of one hand, while with the first and second fingers of the other laid on the lower lid, light rotatory motions are made with the latter over the cornea so as to collect the masses towards the pupil, and then a few rapid light motions upwards with the margin of the lid drive these masses towards and out of the wound.

With an iris forceps the blood clots which may adhere to the wound are now removed, and the incision carefully searched from end to end for any tag of capsule which may lie in it. By passing the forceps into the wound open, and closing it when in the wound several times along its whole length, any tag can be discovered. All this is aptly called the toilette of the wound.

Finally, the coloboma has to be seen to. The peripheral portions of the iris corresponding to the ends of the wound are apt to have become prolapsed in the course of the operation, and to have displaced the angles of the coloboma upwards. If this be not corrected, the prolapsed portion of the iris heals in the wound, and causes a bulging there later on, the pupil gradually becoming drawn up towards the cicatrix. Hence, in every case, even where everything seems to be in order, it is important to pass the narrow spatula (rubber, tortoise-shell, or silver) into the anterior chamber, and to gently stroke down each pillar of the coloboma as far as it can be brought. The previous instillation of eserine will cause the sphincter iridis to assist in producing the desired result.

The sight of the eye should then be tested by finger-counting, as this affords the patient satisfaction, and lends him courage for the next few days of strict quiet.

Having secured the required advantage from the effect of the eserine, a drop of atropine is put into the eye before applying the bandage, in order to do away with the myosis which might give a tendency to iritis.

The dressing is now applied. A piece of boracic lint, sufficiently large to extend ¼ inch beyond the orbital margin in every direction, is soaked in a four per cent. solution of boracic acid and laid on the eye. Pledgets of absorbent cotton wool, soaked in the same solution, are laid on this, the hollows at the inner canthus, etc., being carefully filled up, so that when the bandage is put on it may exert equal pressure on every part of the eye. I apply three turns of a narrow flannel roller over the eye and round

the head, in the manner customary in von Graefe's clinique, but various other, and equally good forms of bandage are in use. The pressure of the bandage need only be sufficient to keep the dressing firmly in its place. It is usual to keep the unoperated eye closed by a light bandage, or bit of court plaster across the lids. The dressing described becomes dry and forms a cake, which adheres to the lids and gives a good hermetic and antiseptic protection.

After-Progress. The smarting of the wound gradually diminishes, until in four or five hours it quite disappears, and from that time the patient has no unpleasant sensation in the eye, except it may be some itching. When the healing process is normal, the first dressing is made in forty-eight hours, in a manner similar to that immediately after the operation, a drop of atropine being instilled, as also at each successive dressing, and a two per cent. solution of carbolic acid used for washing the margins of the lids. The succeeding dressings are made, without antiseptics, every twenty-four hours. On the third day after the operation the patient may be allowed to sit up, the room being still kept dark, and on the fifth or sixth day the bandage may be left aside permanently, and dark glasses worn in its place. In the course of a few days more the patient, having been gradually used to more light, may be allowed out of doors.

Accidents during the Operation. The wound may be made too small. The delivery of the lens, consequently, may be so difficult that the margins of the wound are contused, and then suppuration is very apt to supervene. If the directions above given be carefully attended to,

the largest cataract may be extracted without difficulty, but should the wound be made too small, it can best be enlarged by the forceps scissors, or a blunt-pointed knife made for the purpose.

Hæmorrhage into the anterior chamber may take place. It may be from the iris, from the corneo-sclerotic margin, or from the conjunctiva. Pressure with the spatula on the cornea, which causes the wound to gape, is often successful in clearing the chamber of blood, which might interfere with accurate division of the capsule. Still, when this cannot be completely got rid of, the capsulotomy may be performed with the exercise of greater care.

Prolapse of the Vitreous Humour. This may be due to a too peripheral position of the wound, support being thus taken away from the zonula, and the danger of its occurrence was a disadvantage of the completely corneo-sclerotic wound practised at one time by von Graefe. The Three Millimetre Flap operation is less liable to be attended with loss of vitreous. This accident may also be caused by undue pressure made on the eyeball by the speculum, fixation forceps, or spoon. It may be due to defective zonula with fluid vitreous humour. If the vitreous prolapses prior to delivery of the lens, the latter falls back into the eye, and can only be delivered by at once drawing it out with a Critchett's, Taylor's, or other suitable vectis; and this may be regarded as one of the most serious accidents which can occur in the course of the operation. Loss of vitreous after delivery of the lens is less serious, indeed, a considerable portion of the vitreous may then be lost without ill result to the eye. Still, it increases the traumatism, and renders inflammatory re-

action more liable to occur. Opacities in the posterior chamber of the eye are frequently an ultimate result of loss of vitreous.

Irregularities in the Process of Healing. If the pain should continue longer than the period above mentioned, it is well to quiet it by a hypodermic injection of morphia in the temple of the same side, as otherwise it might give rise to irritation which might lead on to inflammation.

Suppuration of the Wound is a danger which lies between the twelfth and thirty-sixth hour after the operation, rarely either earlier or later, and is a very serious event. Its onset is made known by severe pain of a continuous aching kind in and about the eye, and is thus easily distinguished from the slight, short, stabbing pain with long intermissions, which some patients complain of, and which has no evil import. On removing the bandage the eye will be found full of tears, and the wound covered with a layer of muco-pus, which can be removed with the forceps in one mass, while the aqueous humour and cornea may already present some opacity. In some hours more the corneal opacity increases considerably, the iris becomes distinctly inflamed, and the pupil filled with a mass of inflammatory exudation. The inflammatory process may remain confined to the wound and iris, and when, in the course of some weeks, it entirely subsides, it leaves the pupil drawn up towards the wound, so that an appearance as in Fig. 100 is presented. Or, the inflammation may strike into the ciliary body and choroid, and produce purulent panophthalmitis with total destruction of the eye.

FIG. 100.

To combat suppuration of the wound the most modern method is that suggested by Horner* and Abadie.† These surgeons, at the first onset of the inflammation, open up the wound from end to end with a spatula, evacuate the aqueous humour, and wash out the anterior chamber with injections of a saturated solution of boracic acid, or a five per cent. solution of salicylic acid, while the conjunctival sac is irrigated with a similar solution, and these measures are repeated at intervals of eight to twelve hours. In severe cases Abadie cauterises the whole extent of the corneal wound with a galvano-cautery (platinum wire) at a white heat, a proceeding from which he has had very good results. Other measures, which have been employed to arrest the suppurative process, are, a tight pressure bandage, warm fomentations, etc., but, as a matter of fact, these are of no benefit except in the very mildest cases.

Iritis, apart from that in connection with suppuration of the wound, is most usually due to irritation from masses of cortical lens substance left behind. It may also be due to dragging from a tag of the iris being left in the wound, or to too early exposure to the daylight. Cortical masses do not usually give rise to it for some days after the operation. It is ushered in with the usual symptoms of pain, and is generally of the plastic variety. If it extend to the ciliary body, sympathetic ophthalmitis may result. Its treatment consists in strict confinement to a dark room, atropine, warm fomentations, and leeching. In these cases vision is liable to be damaged by

* *Trans. Internat. Med. Congress*, 1881, Vol. III. p. 13.

† *Annales d'Oculistique*, Vol. LXXXVIII. p. 143, 1882.

pupillary exudation, which remains as a permanent opacity.

Cystoid Cicatrix of the wound is sometimes seen, especially at the extremities. The cicatrix seems bulged forwards and semitransparent, presenting the appearance of a vesicle, and sometimes attaining such a size as to make the eye irritable. The cystoid appearance does not usually come on for some weeks after the operation. In most cases it is caused by a tag of iris which has been allowed to heal in the wound.

If small it need not be interfered with, but if large and causing irritation it is well to abscise a portion of its apex, and to apply a pressure bandage for some days. In case cauterisation be employed, I should prefer the galvano-cautery to nitrate of silver (mitigated) or other caustic application.

The great danger of such cystoid cicatrices is that purulent irido-choroiditis may attack the eye.

Extraction of Cataract in its Capsule. The capsule of the lens being a source of much trouble during the operation, and being liable to produce secondary cataract, the desire of many operators is to remove the lens in its capsule. This method has been chiefly cultivated by Pagenstecher of Wiesbaden. He places the corneal wound below, and, having made a wide iridectomy, passes a spoon behind the lens and draws it out enclosed in its capsule. Pagenstecher does not apply the method to every senile cataract, and his indications are not very well defined. The coloboma below is a serious disadvantage to the operation, as also the danger of prolapse of vitreous. But for these drawbacks, the

method would, beyond doubt, attain to the foremost rank amongst cataract operations.

Discission means the tearing of the anterior capsule with a needle, so as to give the aqueous humour access to the lenticular fibres, which causes them to swell and gradually to become soft and then to be absorbed. The larger the capsular opening the more freely is the aqueous brought in contact with the lens, and the more rapid is its swelling. The rapidity of the swelling and absorption depend also on the consistence of the lens. The softer it is the more rapid is the process, which may require from a few weeks to many months. It is wise to make the first discission of moderate dimensions in order to test the irritability of the eye, especially in adults.

The instruments required are, a spring speculum, a fixation forceps, and a Bowman's stop needle (Fig. 101). The shoulder on the latter instrument prevents its advance too far into the eye. The pupil is to be dilated with atropine.

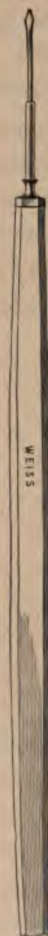


FIG. 101.

The speculum having been applied and the eye fixed at the inner margin of the cornea, the needle is passed perpendicularly through the cornea in its lower and outer quadrant and at a point corresponding to the margin of the dilated pupil. It is then advanced upwards to the upper margin of the pupil (Fig. 102) where it is passed into the capsule, but not deeply into the lens, and a vertical incision effected by withdrawing the instru-

ment slightly. If an extensive opening in the capsule be wished for, a horizontal incision can be added to the vertical, by a corresponding motion of the needle. During these manœuvres the cornea at the point of puncture must form the fulcrum for the motions of the instrument. The instrument is then withdrawn and is followed by some aqueous humour. Atropine is instilled and the bandage applied. The patient is kept quiet in bed in a darkened room for a day, and then the bandage may be left away and dark spectacles worn. The iris is to be

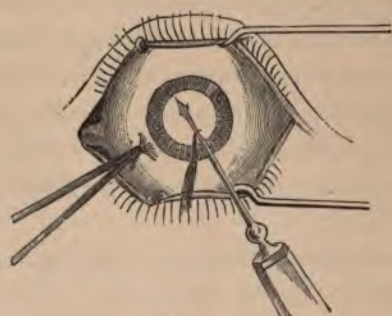


FIG. 102.

kept well under the influence of atropine until the complete absorption of the lens. Repetition of the operation is called for, if the opening be so small as to admit of but a very slow absorption of the lens, or if, as sometimes happens, the opening should become closed up.

This method is applicable to all complete cataracts up to the twenty-fifth year of age, and to those lamellar cataracts in which the opacity approaches so close to the periphery of the lens that nothing can be gained by an iridectomy, and to secondary cataracts which are not too tough.

After the above age, the increasing hardness of the nucleus and the increasing irritability of the iris render the method unsuitable.

Discission is a safe procedure, when used with the above indications and precautions. The danger chiefly to be feared is iritis from pressure on the iris of the swelling lens masses. When this occurs, or is threatened, removal of the cataract by a linear incision in the cornea should be at once performed. A safeguard against iritis may be had in a preliminary iridectomy (v. Graefe), and it is perhaps well to do this in all cases over fifteen years of age, the discission following some weeks afterwards.

Secondary Cataract and its Operation. The term secondary cataract usually means a closure of the opening in the anterior capsule left after the removal of a cataractous lens, with sometimes a thickening of the capsule, by which an impediment is offered to the rays of light in passing through the pupil. The thickening may have pre-existed in the capsule, or it may be due to subsequent proliferation of the epithelial cells on the inner surface of the capsule. The term is also used with reference to those cases in which no central opening has been made in the capsule (peripheral capsulotomy), and where the latter causes imperfect vision. It is also used in those cases where an exudation in the pupil consequent upon iritis has occurred. Finally it is applied to the cases which Fig. 100 represents, where, after suppuration of the wound with irido-cyclitis, the iris is dragged upwards and the pupil consequently obliterated.

The most simple form of secondary cataract occurs as a very fine cobweblike membrane extending over the

whole area of the pupil, which can often only be discovered by careful examination with oblique illumination. It may not appear until some months after the extraction, when the patient will complain of diminished acuteness of vision. It is a simple matter to make a rent in this delicate membrane with a discission needle.

Where there are thick opacities in the capsule, or inflammatory exudation into the pupil, with, probably,

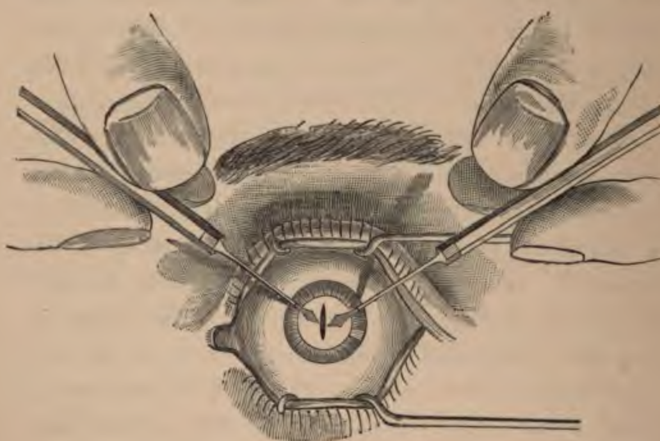


FIG. 103.

adhesions of the iris to the pupillary membrane, extraction of the latter has been proposed and practised, but is associated with so much danger, from the unavoidable dragging on the ciliary body and iris, that the proceeding is not often employed.

Sir W. Bowman's Method with two needles is much preferable. He passes the point of a discission needle through the inner quadrant of the cornea and into the

centre of the opacity (Fig. 103), and then, with the other hand, a second needle through the outer quadrant of the cornea and into the membrane close beside the first needle. The points of the needles are now separated from each other by approximation of their handles, and a hole made in the membrane; a very small opening, if quite clear, being sufficient to establish good vision.

*Dr. Noyes' Method.** A Graefe's cataract knife is entered in the horizontal diameter of the cornea at its temporal margin, and a counterpuncture made in the same diameter at the inner corneal margin. The point is now withdrawn into the anterior chamber and made to puncture the secondary cataract, and then removed from the eye. Two blunt-pointed hooks are then entered into the anterior chamber, one through each corneal puncture, and the point of each passed through the opening in the membrane made with the knife. By traction on the hooks this opening is enlarged without any dragging on the iris or ciliary body.

Iridotomy. For the cases as in Fig. 100, where the iris forms a complete and tightly stretched curtain across the pupil, iridectomy is the operation which readily suggests itself. In very few cases, however, does it give a satisfactory result, owing to the inflammatory products which lie behind the iris, and which close up any artificial pupil by their proliferation, set going by the dragging of the iris with the forceps. Repeated iridectomies may finally produce a clear pupil, but iridotomy is a better operation in these cases. There are several modes of performing the latter, the best being that of de Wecker. Making an inci-

* *Diseases of the Eye.* London, 1882, p. 251.

sion in the cornea about 3 mm. long and the same distance removed from its inner margin, and perpendicular to its horizontal diameter, the closed blades—one of which has a sharp point—of de Wecker's forceps-scissors are passed into the anterior chamber. The blades are then opened, and the sharp point of one of them is forced through the stretched iris and some 3 or 4 mm. behind it. By now closing the blades the tightened iris fibres are cut across, and on their retraction a central clear pupil is formed in the iris and retro-iritic tissue.

Dislocation of the Crystalline Lens. This may be congenital and due to arrested development of the zonula of Zinn, or it may be the result of disease, such as anterior sclero-choroiditis, or it may be caused by a blow or other trauma.

The dislocation may be partial or complete. In the former case it is often so slight as to be discoverable only when the pupil is widely dilated, the margin of the lens becoming then visible as a black line in some one direction by aid of the ophthalmoscope. Or, the displacement may be so great as to bring the margin of the lens across the centre of the undilated pupil, in which case one part of the eye will be highly hypermetropic, while in another part it will be myopic. Complete dislocation may take place into the anterior chamber, into the vitreous humour, and under the conjunctiva, the sclerotic having been ruptured.

The symptoms in partial dislocation are those of loss of power of accommodation and monocular double vision. Iridodonesis (shaking of the iris) is present as a rule, in consequence of the loss of support provided by the

lens. In complete dislocation the symptoms are those of aphakia; *i.e.*, extreme hypermetropia, and want of power of accommodation.

Treatment. In partial dislocation it is rarely that any treatment can be of service. The prescribing of spectacles suited to the faulty refraction is indicated. In complete dislocation of the lens into the anterior chamber its extraction is usually required, especially if it cause symptoms of irritation. Dislocation into the vitreous humour is generally unattended by irritation; but when the latter arises, removal of the lens by aid of a spoon through a peripheral incision has to be attempted.

Aphakia, or **Absence of the Crystalline Lens.** The condition of the emmetropic eye after the removal of a cataract is one of high hypermetropia, and the power of accommodation is wanting. Consequently, in order that the eye may have the best possible sight for distant objects, a high convex glass has to be experimentally found to suit it.

The degree of vision varies considerably in different cases; frequently $V = \frac{6}{6}$ is obtained, but $V = \frac{6}{18}$ may be regarded as a satisfactory result, and even lower degrees, which enable the patient to find his way about with comfort, are classed as successful operations. For reading, writing, etc., at about 25 cm., a still higher convex glass must be provided. If the correcting lens for distant vision be + 10 D, its power for vision at 25 cm. must be increased by the lens which would represent the amplitude of accommodation from infinite distance up to 25 cm. This lens is 4 D (because $\frac{100}{25} = 4$), therefore + 14 D is the lens required. With these two lenses

most patients are satisfied. For distinct vision at middle distances they learn to vary the power of the lenses by moving them a little closer to, or farther from the eye; but, if necessary, a lens can be prescribed for distinct vision at any desired distance. In a large number of cases, after cataract operations, the best vision is not obtained until existing astigmatism is corrected. High degrees of astigmatism are often present after cataract operations, in eyes which previously were free from it. This may be due to astigmatism of the cornea having been formerly compensated by an opposite form of astigmatism of the lens, or it may be the result of cicatricial contraction of the corneal wound.

CHAPTER XVII.

DISEASES OF THE VITREOUS HUMOUR.

Purulent Inflammation of the Vitreous Humour (to which unfortunately the name pseudo-glioma is sometimes applied) occurs only as the result of perforating injuries, or of the lodgement of a foreign body, or as an extension of a purulent process from the choroid.

Ophthalmoscopically, a purulent deposit in the vitreous humour gives a yellowish reflexion. It is to be distinguished from a somewhat similar appearance in glioma of the retina by the history, by its early complication with more or less severe iritis, by the very frequent retraction of the periphery of the iris, and by the diminished tension of the eye, while the lobulated appearance is not so usual as in glioma. Again, in glioma the vitreous humour remains clear, while in this condition it is hazy.

The condition, if at first confined to the vitreous humour, soon extends to the surrounding tissues, and usually leads to panophthalmitis and complete destruction of the eye.

Inflammatory Affections of the Vitreous Humour, other than the purulent form, are, for the most part, the consequence of diseases of the choroid, ciliary body, or

retina, and display themselves as opacities of various kinds. These are either cells derived from the primarily diseased tissue, or they are secondary changes (connective tissue development) the result of this cellular invasion.

The chief *Varieties of Vitreous Humour Opacities* are: —1. The Dust-like Opacity so characteristic of syphilitic disease of the retina and choroid. It may occupy the entire vitreous humour, but is frequently confined to the region of the ciliary body, or to that of the posterior layers of the vitreous humour. 2. Flakes and threads. These are formed with chronic affections of the choroid or ciliary body, and may be the result also of hæmorrhages into the vitreous humour. They invade every portion of the humour. 3. Membranous opacities, which are rare, and are probably the result either of extensive hæmorrhagic extravasations or of choroidal exudations.

Hæmorrhages into the vitreous humour are not uncommon, and are the result of diseases of the retina and choroid, which are accompanied by hæmorrhages in those membranes. Most of the alterations occurring in the vitreous humour are attended with or give rise to fluidity of it.

The Diagnosis of opacities in the vitreous humour is made with the ophthalmoscopic mirror and a not very bright light, or with the plane mirror. If a very bright light and a concave mirror be employed, the finer opacities will not be readily seen. The pupil being illuminated, the patient is directed to look rapidly in different directions, when the opacities will be seen to float across the area of the pupil as they are thrown from one side of the eye to the other.

The ophthalmoscope does not always detect changes in the choroid or retina where there are opacities in the vitreous, and in many such cases we are led to the belief that the diseases in these membranes are too fine to be seen with the ophthalmoscope, or that they are situated in the region of the ciliary body which is out of view.

Vision is affected by opacities in the vitreous humour in proportion to their density, and to the extent to which the vitreous humour is occupied by them. The patients often observe them as floating positive scotomata in their field of vision. These "entoptic appearances" are caused by the shadows of the opacities thrown on the retina.

The Prognosis depends on the cause of the opacities. Small hæmorrhagic extravasations in young people are readily absorbed. The dust-like opacity of specific retinitis is also favourable for absorption, while extensive hæmorrhages in older people, and the "flake and thread" opacities, frequently remain as permanent obstructions. Moreover, by shrinking, many of the more organized opacities give rise to detachment of the retina from the choroid, and consequent blindness.

Treatment consists, above all, in that for the exciting cause. Heurteloup's artificial leech, or dry cupping on the temple are most useful, and in many cases, soon after their application a marked clearing up of the vitreous is apparent. Pilocarpine hypodermically is worthy of trial. In one case v. Graefe operated on membraneous opacities by tearing them with a needle, and with a successful result.

Mouches Volantes, or **Muscæ Volitantes,** is the

term applied to those motes which people frequently see floating before their eyes, but which do not interfere with the acuteness of vision, nor can the ophthalmoscope detect opacities in the vitreous humour, or other intra-ocular disease. They are most apparent when a bright surface is looked at, such as a white wall or the field of a microscope. Mouches volantes have no clinical importance. Those annoyed with them should be strongly recommended not to look for them, as in that case others are very apt to become visible. They depend probably upon minute imperfections in the structure of the vitreous humour.

Fluidity of the Vitreous Humour (Synchysis) is not rare. It can only be diagnosed with certainty when the humour contains floating opacities. Low tension of the eyeball does not always indicate fluidity of the vitreous, although soft eyeballs nearly always contain fluid vitreous humour. Trembling of the iris is also no sign of fluid vitreous, but merely indicates that the iris is not supported in the normal way by the crystalline lens. Defective zonula of Zinn, however, is often caused by, or is a concomitant of fluid vitreous, and, causing displacement of the lens, would allow of trembling of the iris. The causes of synchysis are choroiditis, staphyloma of the choroid and sclerotic, and it also occurs as a senile change.

Synchysis Scintillans is a fluid condition of the vitreous humour, with chlorestearine and tyrosine crystals held in suspension in it. The ophthalmoscopic appearances are very beautiful, resembling a shower of golden rain. A satisfactory explanation for the occurrence of

these crystals in this position has not yet been given. They usually occur in old people, and seldom cause any marked deterioration of vision.

Fluidity of the vitreous humour is not, *per se*, a condition of serious import, unless the eye come to be the subject of an operation involving an incision in the corneo-sclerotic coat, when it renders prolapse of the vitreous more liable to take place.

Foreign Bodies in the Vitreous Humour. One of the most common accidents to the eye is perforation of the sclerotic by small foreign bodies (shot, morsels of iron, stone, or glass), which then lodge in the vitreous humour. It is sometimes not easy to say, in cases where the ophthalmoscope fails us owing to extravasation of blood, etc., whether the foreign body be in the eye, or whether it may merely have punctured the sclerotic and fallen to the ground. If it be a small foreign body, and it have flown against the eye with force, the probabilities are that it has lodged in the eye. If the case be brought immediately or soon after the accident, and there be no intraocular hæmorrhage to obscure our view, the foreign body may frequently be detected with the ophthalmoscope in the vitreous humour as a dark or glittering body, according to its nature. Or, if it cannot be seen, an opaque streak through the vitreous humour, one end of which corresponds with the sclerotic wound, may indicate the track taken by a foreign body. If the foreign body has perforated the cornea and reached the vitreous humour through the circumlental space, a counter-opening will be found in the iris. Focal illumination with dilated pupil will often help us to discover a

foreign body situated in the anterior portion of the vitreous humour.

Small foreign bodies in the vitreous humour sometimes become encapsuled after a time in a layer of connective tissue, and remain dormant in the eye without giving rise to further mischief. This event is rare, and should not be calculated on in our treatment of such cases. As a rule, foreign bodies in the vitreous humour soon produce violent inflammatory reaction, and form one of the surest sources of sympathetic ophthalmitis. It is consequently of the utmost importance to remove them from the eye, if possible; or, carefully to watch the eye, and at any sign of serious inflammatory reaction to remove the eyeball.

Removal of the Foreign Body should always be attempted, when, being neither steel nor iron, it is visible within the eye, so that its position can be determined with the ophthalmoscope or focal illumination. The introduction of the magnet for the removal of fragments of the two metals named has made it unnecessary that they should in every case be visible. Atoms of glass, copper, stone, etc., can only be removed through an incision in the sclerotic, which is either an enlargement of the opening made by the foreign body, or is a special one at a point more nearly corresponding to its actual position in the eye. This incision should lie between two recti muscles. Prolapse of the vitreous is then produced by pressure on the eyeball, and the foreign body evacuated. Or, a forceps is passed in through the opening, and while the foreign body is kept in view with the ophthalmoscope it is seized and drawn out. The first of these methods should only be tried when the foreign body is situated in the periphery

of the vitreous and towards the equator of the eye, where the opening for its exit can be made in its immediate neighbourhood; but the proceeding is often attended with disappointment, much vitreous being lost while the foreign body remains in the eye. The second plan is also unsatisfactory; as, loss of vitreous occurring, the cornea becomes flaccid and the view of the foreign body soon obscured. A forehead mirror, such as that proposed by J. E. Adams,* would be the most convenient instrument in these cases. These procedures are so seldom attended with success, that it is well to obtain the patient's consent for immediate enucleation, should the foreign body not be extracted.

The magnet, thanks to the efforts of M'Keown, of Belfast,† has of late years come into use for the removal of fragments of steel and iron from the interior of the eye, and especially from the vitreous humour. Electro-magnets are those now employed for this purpose, and the instruments of Hirschberg,‡ and of Simeon Snell,§ are the most suitable. The figure on the next page represents Mr. Snell's instrument in two-thirds its actual size. It is a core of soft iron, around which is placed a coil of insulated copper wire, the whole enclosed in an ebonite case. To one end of the instrument are attached the screws to receive the battery connections. At the other extremity the core projects just beyond the ebonite jacket, and is tapped, and into it screws the needle.

* *Trans. Ophthal. Soc. of the United Kingdom*, Vol. III. p. 296.

† *Brit. Med. Journal*, 1874, Vol. I. p. 800, and elsewhere.

‡ *Centralblatt für prak. Augenheilkunde*, 1879, p. 380.

§ *The Electromagnet*, &c. London, 1883.

Needles of various kinds or shapes can be adjusted to the magnet according to the case to be dealt with. The battery used is a quart bichromate element. A needle being passed through the sclerotic opening is advanced towards the foreign body, when the latter adheres to it and is drawn towards the wound. Much care is required in drawing it through the opening lest it be rubbed off the needle in its passage. A forceps is generally used at this part of the proceeding, either to dilate the wound or to seize the foreign body and extract it.

FIG. 104.

The magnet may also be used for determining the presence of a fragment of steel or iron in the vitreous, if, on bringing it close to the eye, motions are imparted to the fragment. T. R. Pooley * made some very elegant experiments for ascertaining the presence of a piece of steel in the eye, based on the principle that if a fixed magnet attracts a movable piece of steel a fixed piece of steel will attract a movable magnet. He magnetised a sewing needle, and suspended it by a fibre of silk attached to its centre, and on bringing it near an eye which contained an atom of steel the needle would

* *Archives for Ophthalmology*, 1880, p. 219.

dip towards the foreign body. Or, if he magnetised the foreign body by passing a galvanic current through the eye, the motion of the suspended magnet was even more decided.

Cysticercus in the Vitreous Humour is not of rare occurrence in some parts of Germany, but there have been but one or two such cases observed in the British Isles.

Persistent Hyaloid Artery. In intra-uterine life the hyaloid artery is a prolongation of the central artery of the retina, and runs from the papilla to the posterior surface of the crystalline lens. It completely disappears prior to birth, except in those rare cases where it remains as an opaque string, which may stretch the whole way from papilla to lens, or extend only part of the way. It is thrown into wave-like motions by the motions of the eyeball.

Detachment of the Vitreous Humour from the Retina is nearly always the result of injuries, such as cataract extractions and other perforating wounds; either from loss of vitreous, or as the result of shrinking of the degenerated vitreous. In uninjured eyes, too, it occurs in connection with high degrees of myopia, and with anterior staphyloma, occasionally also from extravasation of serous, purulent, or hæmorrhagic fluids, or from neoplastic growths between the vitreous and retina. In all these connections it is not so much an object of separate clinical diagnosis as of pathological interest; indeed, its ophthalmoscopic appearances have not been defined. Moreover, it rarely is the direct cause of blindness. I have* recorded a case in which detachment

* *Trans. Ophthal. Soc.* 1882, p. 41.

of the vitreous was the chief lesion in the eye, and was the cause of blindness, the vision being reduced to perception of light. The detachment had probably been brought about by hæmorrhage in the anterior part of the vitreous from the ciliary body. It lay (Fig. 105) immediately behind the lens, and in contact with it, and

FIG. 105.

presented the appearance of a greyish opacity, much like a detached retina but for the absence of retinal vessels. Suspicion of an intraocular tumour existing, the eye was removed. The vitreous lay against the ciliary body and lens, while the vitreous chamber was filled with serous fluid and the retina was in its normal position. In the retina towards the ora serrata were a few minute hæmorrhages.

CHAPTER XVIII.

DISEASES OF THE RETINA.

Purulent Retinitis is observed as the result of septic embolism of the retinal arteries in septicæmia after surgical operations, etc., and very frequently in cases of metria. In an early stage the ophthalmoscope shows a number of small hæmorrhages in the retina with general cloudiness of the retinal tissues, while the actual embolisms (usually multiple) may not be visible. The inflammation makes rapid progress, soon destroying sight and extending to the choroid, iris, and vitreous humour, until finally panophthalmitis is reached. The retina is sometimes alone the primary seat of the embolic attack, and sometimes the choroid also is involved. The embolisms are often little more than masses of micrococci.

The retina becomes secondarily implicated in many purulent processes which commence in other parts of the eye.

Hæmorrhagic Retinitis. In this affection the retina contains a number of small hæmorrhages. They occur chiefly between the fibres of the inner layer, and consequently present a flame-like appearance as seen with the ophthalmoscope. Any which lie in the outer layers are more apt to be round or irregular in shape. In

addition to the hæmorrhages, there is diffuse opacity of the retina, and sometimes white spots of degeneration. The papilla is often much swollen, and the retinal veins distended and tortuous, while the arteries are small; but these appearances, as well as the number of the hæmorrhages, vary much in different cases. When there are but few hæmorrhages, they are situated in the neighbourhood of the papilla and macula lutea. The appearances occasionally resemble those of albuminuric retinitis, but in the latter, as a rule, the proportion of white spots to hæmorrhages is greater than in this affection.

Causes. The affection is found most commonly in connection with cardiac disease, *e.g.*, valvular insufficiency and hypertrophy of the left ventricle; or, with diseases of the vascular system, *e.g.*, atheroma, and aneurysms of the large vessels. Where it is due to disease of the coats of the arteries, the ophthalmoscope will occasionally reveal an arterial branch altered to the appearance of a white thread; but usually the degenerative change does not interfere with the transparency of the vascular coats. In the majority of cases dependent on cardiac or vascular disease, the retinal affection is monocular. This, and the frequently sudden onset of the retinitis, leads Leber* to think, that some second factor for its occurrence exists, probably multiple embolisms of the small branches of the central artery. Suppression of menstruation or other wonted discharge has been observed as a cause of hæmorrhagic retinitis.

A peculiar form of hæmorrhagic retinitis is sometimes associated with secondary syphilis. In addition to the

* *Graefe und Sæmisch's Handbuch*, Bd. V. p. 570.

usual opacity of the retina in syphilitic retinitis (*vide infra*), a portion of the retina is covered with numbers of small round hæmorrhages lying in the different layers of the retina, while a connective tissue development is occasionally found in the nerve fibre layer, in the form of white striæ along the course of the blood-vessels.

The disturbance of vision is considerable, especially if the neighbourhood of the macula lutea be much involved.

The Prognosis is bad in severe cases, relapses being frequent, while the ultimate tendency is towards atrophy of the retina and papilla. In very mild cases recovery may come about.

The Treatment must be chiefly expectative, or directed, at most, towards procuring rest for the general system, or for the organ primarily at fault. Dry cupping on the temple, hot foot baths, and iodide of potassium internally may be employed.

Apoplexy of the Retina. This differs from the last described disease, in that the hæmorrhages are found in a retina free from other diseased appearances, especially no retinitis.

With the ophthalmoscope, the extravasations of blood appear as red or almost black spots of various sizes and shapes. Their number and position in the fundus are also variable. They may be in any layer of the retina, and may sometimes burst into the vitreous humour, and sometimes become extravasated between the retina and choroid.

Vision is interfered with according to the position and extent of the hæmorrhages. Wherever an apoplexy be

situated, the function of the retina at that place is suspended; and if it be at the macula lutea, central vision will be seriously impaired; but the scotoma produced by an apoplexy at the periphery of the fundus may pass unnoticed by the patient.

The apoplexies are absorbed in the course of weeks or months, becoming paler and smaller, often leaving after them choroidal changes, or greyish spots dependent on degeneration of the retina, and in some extreme cases atrophy of the retina may result. Glaucoma comes on as consecutive to retinal apoplexies in some instances. It is then known as hæmorrhagic glaucoma, and is an almost incurable form of the disease.

Occasionally, absorption of the hæmorrhages is accompanied by complete restoration of vision, but usually the scotomata remain. Recurrences of the hæmorrhages are very common.

Causes. Retinal apoplexies are most common in advanced life, with atheroma of the bloodvessels, and are then valuable as a warning of possibly impending cerebral mischief. Other causes are:—Hypertrophy of the left ventricle. Suppression or irregularity of menstruation, or at the climacteric period. The sudden reduction of tension of the eyeball after iridectomy for glaucoma. The gouty diathesis (Hutchinson). Progressive pernicious anæmia, or anæmia from loss of blood (hæmatemesis, etc.), or from exhausting diseases. In connection with this latter cause of retinal apoplexy, Stephen Mackenzie has pointed out * that when the corpuscular richness of the blood falls below fifty per cent., whatever the cause of

* *Trans. Ophthal. Soc.* 13 Dec. 1883.

the anæmia, the tendency to retinal hæmorrhage is present.

In young people of both sexes, from the fourteenth to the twentieth year of age, large retinal apoplexies are not rare, and it is difficult to assign a cause for them. Some of the subjects are weak or anæmic, but many of them are in perfect health. Neither Eales* nor Nieden † have found these apoplexies in young women, but this does not conform with the experience of others.

Prognosis. Despite frequent recurrences, many of these cases recover perfectly; in others glaucoma comes on; or, the hæmorrhage, having invaded the vitreous humour, may give rise to dense permanent opacity in it, followed, perhaps, by detachment of the retina.

Treatment. Active measures are of little use. Cold compresses at first, with a pressure bandage, and dry cupping to the temple may be employed. The general state of the patient must be attended to, and no violent muscular efforts permitted.

Retinitis Albuminurica occurs as a complication in many cases both of acute and chronic nephritis, and in the albuminuria of pregnancy. It is most common with the granular kidney, but may attend any chronic form of Bright's Disease.

The defect of vision in the chronic form, although often an early or even the first symptom, is never associated with an early stage of the kidney disease, but with a late stage of it, and with dilated left ventricle. Both eyes are affected, vision is much lowered, and even per-

* *Ophthalmic Review*, 1882, p. 41.

† *Bericht d. Ophthal. Gesellsch.* 1882.

ception of light may be wanting; but the blindness is not always all due to organic changes in the retina, being often largely the result of uræmia.

Ophthalmoscopic Appearances. These are:—Venous hyperæmia and swelling of the papilla and of the retina in its neighbourhood; hæmorrhages on the papilla and in the nerve fibre layer of the retina; and round, or irregularly shaped white spots in the retina, arranged in a zone around the papilla, some three papilla diameters from it; these changes taking place in the order in which I have enumerated them. The hyperæmia and engorgement of the veins, often very great, become less as the white spots are more developed. Near the macula lutea no very coarse changes usually occur, but fine white dots are found, with a star-like arrangement converging towards the macula. The degree in which all these different changes are present varies in different cases, no one of them being pathognomonic of the kidney affection, but rather the grouping of the whole picture being suggestive. Sometimes the papillitis is so intense as to simulate that formerly known as "congestion papilla" in cases of intracranial tumour, while the white spots are sometimes so developed as to become confluent, and to form one large white plaque. Again, the papillitis, or white spots, or both, may be but slightly marked. The number and size of the hæmorrhages are also liable to great variation. Detachment of the retina has been observed in a few cases,* and in some the hæmorrhages burst into the vitreous humour. Occasionally, if the general disease remain stationary, or improve, or recover, the retinal

* C. E. Fitzgerald, *Trans. Ophthal. Soc.* 1881, p. 58.

changes may improve or disappear, and leave the retina with normal appearances and functions; or, the swelling, hyperæmia, white spots, and hæmorrhages may give place to optic atrophy, with diminution in size of the arteries, and pigmentary alterations in the retina.

Some of the white spots are caused by fatty degeneration of the outer layers of the retina (the retinal vessels passing over them), others by hypertrophy of the nerve fibre layer (the retinal vessels hidden by them). The fine dots about the macula lutea are the result of fatty degeneration of the inner ends of Müller's fibres.

The connection between the renal and retinal affections is not known with certainty, but the theory that the latter is due to chronic uræmia is probably correct.

Retinal Affections in Diabetes. There is no one condition of the retina characteristic of diabetes, although undoubtedly retinal affections occasionally do complicate it in an advanced stage. Small retinal hæmorrhages with fine changes about the macula lutea, somewhat similar to the star-like appearance in Bright's Disease, form perhaps the most common appearances. In other cases retinal hæmorrhages alone are found, and in others hæmorrhagic retinitis, while, again, the so-called typical appearances of Bright's Disease may be presented. There are often opacities of hæmorrhagic origin in the vitreous humour, and iritis may come on. Leber lays down the rule, that, in all cases of retinal hæmorrhages, and of retinitis hæmorrhagica, the urine should be examined for sugar.

Retinitis Leucæmica. In not more than one-third or one-fourth (Leber) of the cases of leucocythemia does

a retinal affection occur, and it is not always of the same type. It may consist in a slight diffuse retinitis accompanied by some extravasation of pale blood, while the bloodvessels are also pale, the veins being much distended and the arteries small, and the choroid of an orange-yellow colour. Or, it may resemble rather a case of ordinary hæmorrhagic retinitis.

The appearances most characteristic of the affection are :—Slight opacity of the retina, especially along the vessels ; the papilla pale, with indistinct margins ; small hæmorrhages ; round white elevated spots up to 2 mm. in diameter, with a hæmorrhagic halo, situated by preference towards the periphery of the fundus and at the macula lutea, but not at all, or only in very severe cases, in the zone between the macula and the equator of the eye. These white spots consist of extravasations of leucæmic blood, the result, Leber thinks, of diapedesis.

Vision may be but little affected if the macula lutea be fairly free. Hæmorrhage into the vitreous humour may cause complete blindness.

Syphilitic Retinitis (or Choroido-Retinitis). Inherited or acquired constitutional syphilis is liable to induce a form of chronic diffuse retinitis. In the acquired disease it is a later secondary symptom, coming on between the sixth and eighteenth month, often only in one eye.

With the Ophthalmoscope a light opacity of the retina is seen extending from the papilla some distance into the retina, and very gradually disappearing towards the equator of the eye. The papilla is but slightly hyperæmic, while its margins are indistinct, like those of the moon seen through a light cloud. The artery is not

generally altered, and the vein but slightly distended. Opacities in the vitreous humour are not uncommon. They may be membraneous or thread-like, but a diffuse dust-like opacity filling the whole vitreous humour is almost pathognomonic of a syphilitic taint, and may create much difficulty in the ophthalmoscopic diagnosis of the retinal affection.

Disseminated choroidal changes in the form of small yellowish spots with pigmentary deposit are very frequent, especially towards the equator of the eye. Many observers, indeed, hold that the whole process is primarily in the choroid, and that the retina is only secondarily affected. Fine whitish dots and pigmentary changes often occur about the macula lutea.

Vision may be but slightly affected, but in the advanced stages it is usually much lowered. Central or peripheral scotomata, or concentric defects of the field, are found. The scotomata are often positive; *i.e.*, they can be seen by the patient as dark spots in the field. Night-blindness is a constant symptom. The patients sometimes complain of sparks or lights, which seem to dance before their eyes, and occasionally also of a diminution in the size (micropsia) of objects, or of a distortion (metamorphopsia) of their outlines. The micropsia is believed to be due to a separation from each other of the elements of the layer of rods and cones by subretinal exudation. The image of an object then comes in relation with fewer of these elements, and, hence, the mental impression is that of a smaller object than is conveyed by the image formed in the sound eye, or on a sound part of the same retina.

The Progress of the Disease is very slow and is liable to relapses. In the late stages extensive pigmentary degeneration of the retina may come on, or disseminated choroiditis. But, if the cases come under suitable treatment in an early stage, a cure may often be effected.

Treatment. The only remedy which is of real value is mercury, and that in an early stage. It should be used in a protracted course of some weeks by inunction, combined at discretion with small doses of calomel internally. If mercurialization be effected, it should not go further than a very slight stomatitis. Pilocarpine hypodermically, Turkish baths, and the artificial leech at the temple may be employed as adjuncts to the treatment. When the mercurial course has been completed, iodide of potassium should be prescribed as an after-treatment.

Retinitis Pigmentosa is rather a degenerative than an inflammatory affection of the retina. It is extremely chronic in its progress, coming on in childhood and often resulting in complete blindness in advanced life.

Vision is much affected, but the symptom most complained of is night-blindness (nyctalopia). The field of vision becomes gradually contracted, until only a very small central portion remains, so that, although the patient may still be able to read, he cannot find his way alone, a function for which the eccentric parts of the field are the most important. Finally, the last remaining central region becomes blind.

The Ophthalmoscopic Appearances consist in a pigmentation of the nerve fibre layer of the retina, which commences in the periphery, and in the course of years

advances towards the macula lutea. The pigment is arranged in stellate spots, of which the processes intercommunicate, so that the appearance reminds one of the Haversian system of bone. Pigment is also deposited along the course of many of the vessels, hiding them from view. The degree of pigmentation varies much, and in some cases is quite absent, and the diagnosis then has to depend upon the other appearances, and on the symptoms. The papilla is of a greyish-yellow colour, never white, and the vessels are very small.

The choroid is sometimes slightly affected, irregularity in its pigmentation being observable.

The pigment in the retina is believed to wander into it from the pigment-epithelium layer. The other pathological changes in the retina consist in hyperplasy of its connective tissue elements, and thickening of the walls of the vessels at the expense of their lumen.

Retinitis pigmentosa often affects more than one member of a family, the patients being frequently defective in intelligence, or deaf and dumb. Many of these are the offspring of marriages of consanguinity, and in others an inherited syphilitic taint is present, while in others no cause can be assigned.

Treatment is of little use. At best one may stimulate the torpid retina by hypodermic injections of strychnia, or with the continuous current. The latter means has found an advocate in Dr. Gunn,* and I have seen several cases much benefited by it for a time.

Retinitis Punctata Albescens (Mooren), **Retinitis Centralis Punctata et Striata** (Hirschberg). A few

* *Ophthal. Hosp. Rep.* Vol. X. p. 161.

cases of this peculiar affection have been described.* These have occurred in middle-aged or elderly people whose general health was good, or, if disordered, was not similarly so in any two cases. The defect of vision may come on rapidly, or may be gradually developed in the course of many years. It consists in a lowering of the central vision with positive or relative scotoma, or both may be present; but the eccentric field remains intact.

The ophthalmoscope discovers great numbers of minute white glistening dots and fine white striæ in the retina, chiefly between the papilla and macula. A retinal hæmorrhage was noted in one case, and in only one was slight papillitis present. The affection is probably of inflammatory origin.

Treatment consisted in Heurteloup's leech, iodide of potassium, protection of the eyes, and care of the general health. Cure took place in one case, while in no instance did serious blindness come on.

Development of Connective Tissue in the Retina. Extensive white striæ are sometimes seen in the retina, which may conceal the vessels and papilla, and which are the result of hæmorrhages according to Leber, and of an inflammatory process according to Manz. Hæmorrhages in the retina and vitreous humour are generally present at some period. Vision is often but slightly affected, but the danger of recurrent intraocular hæmorrhages renders the ultimate prognosis bad as a rule.

Treatment. Heurteloup's leech. Iodide of potassium or perchloride of mercury. Protection spectacles.

* Mooren. *Fünf Lustren Ophthalmologischer Wirksamkeit*, p. 216; Hirschberg. *Centralblatt f. prak. Augenheilkunde*, 1882, p. 330.

Detachment of the Retina. The retina becomes detached from the choroid by effusion of fluid, usually serum. In a general way the term is not employed when only a solid neoplasm lies between retina and choroid.

If the media be clear and the detached portion exten sive the diagnosis is not difficult.

The Ophthalmoscope shows a greyish reflex from a position in front of the fundus oculi, and to the surface from which the reflex is obtained a wave-like motion is imparted when the eyeball is moved. Over this greyish surface the retinal vessels run. They seem black, not red, in consequence of absorption of the transmitted light, and are hidden from view here and there in the folds of the detached retina.

The detachment may commence in any portion of the fundus, but, owing to gravitation of the fluid, it ultimately settles in the lower half of the fundus, and, hence, this is the most common place to find it, the part first detached having become replaced. The diagnosis is more difficult if there be but little fluid behind the retina, or, if there be opacities in the vitreous humour.

Vision is affected according to the position and extent of the detachment. Central vision may be quite normal if the macula lutea and its immediate neighbourhood are intact. The patients complain of seeing objects distorted, of a black veil which seems to hang over the sight, and of black floating spots before the eye (opacities in the vitreous humour). These symptoms often come on suddenly in an eye which has hitherto had good sight.

The field of vision on examination will show a defect

corresponding to the position of the detachment. Thus, if the latter be below, the defect will be in the upper part of the field. If the detachment be fresh (retina not yet undergone secondary changes), and the quantity of sub-retinal fluid not great, the defect may only amount to an indistinctness of vision; but, later on, when infiltration and connective tissue degeneration of the detached part come about, fingers may not be counted at the same place. The phosphenes* of the detached portion are wanting.

Should the detachment become complete, little more than power of perception of light may be present. Total detachment is followed by cataract, and often by iritis, and phthisis bulbi. The detachment may remain stationary and not extend to the whole fundus, or the fluid may even become absorbed, and the retina return to its normal position. Such a happy result, however, is most rare.

Causes. Probably the most common cause is progressive myopia (p. 34), but it is still uncertain what the connecting link here is; whether, with progressive posterior staphyloma, there is a tendency to serous exudation from the inner surface of the choroid; or whether, the detachment is simply a mechanical result of the lengthening of the globe.

* Phosphene is the subjective sensation of light experienced when the eyeball is pressed upon. For clinical purposes it is best tested by gentle pressure with a blunt point (head of a bodkin, or large-sized probe) applied to the eyeball through the eyelid. The phosphene of any region is tested by applying pressure at the opposite side of the globe; thus, if in a healthy eye the individual look down, and pressure be applied to the upper part of the globe through the eyelid, the phosphene will be seen appearing below, but if there be a detachment of the retina in that place no phosphene is seen.

Blows upon the eye may produce detachment of the retina, the exuded fluid being serous or bloody. Punctured wounds of the sclerotic, also, in the course of healing, by reason of contraction of the cicatrix dragging on the retina. Disease of the vitreous humour causing shrinking of it may result in detached retina, the latter being drawn away from the choroid. Intraocular tumours, especially those situated in the posterior segments of the fundus, usually give rise to detachment in an early stage of their growth, and the complication renders their diagnosis more difficult (p. 221).

Leber* has found that a perforation in the detached portion is very common; and inclines to the view, that it precedes the occurrence of the detachment, and is caused by traction of the shrinking diseased vitreous, which then, pressing through the opening, separates the retina from the choroid.

Treatment. Evacuation of the subretinal fluid by puncture of the sclerotic was first proposed by Sichel, and has lately been cultivated by de Wecker. He uses an instrument like a broad needle with a sharp point and two blunt edges, which is entered through the sclerotic and choroid at a point corresponding to the position of the detachment, but not so deeply as to reach the retina, lest thereby it be further displaced. The instrument is then given a quarter of a rotation to make the wound gape, and admit of the flowing off of the fluid. If possible, a position near the equator of the globe, and between two recti muscles, should be selected for the operation. Moreover, the incision should lie parallel to the direction of the

* *Bericht d. Ophthal. Gesellsch.* 1882, p. 18.

orbital muscles, so that the choroidal vessels may be injured as little as possible. A firm bandage is applied, and the patient kept in bed for eight or ten days.

The dorsal position in bed, with a pressure bandage on the eye, maintained for from four to six weeks, has produced reposition of the detachment in some cases. The method is most trying to the patient.

Pilocarpine used hypodermically has been praised by some as a mode of treatment. Perhaps a combination of all those methods might be useful, along with dry cupping on the temple.

Formerly an active antiphlogistic treatment used to be employed, with the object of obtaining absorption of the fluid.

The fact that partial cure occasionally takes place spontaneously, by bursting of the retina and extravasation of the fluid into the vitreous humour, led von Graefe to puncture the detachment from the inside, by entering a double-edged needle 10 mm. behind the temporal margin of the cornea into the vitreous humour, and dividing the detachment by pressure of the edge of the needle against it. Other methods, which need not be described, have been proposed for the cure of this condition.

The Prognosis of every case of detached retina is bad, spontaneous cure being extremely rare, and the treatment of the disease remaining one of the weakest points of ophthalmic therapeutics. Moreover, both eyes are apt to be affected one after the other. The cures by any one or any combination of the above methods of treatment are few and far between, and when, sometimes, the subretinal

fluid is got rid of, and the retina returns to its place, there is still the danger of a recurrence of the detachment. The most favourable cases are those due to choroiditis, the most unfavourable those due to posterior staphyloma.

Embolism of the Central Artery of the Retina. Sudden or very rapid blindness, beginning at the periphery of the field, and advancing towards the centre, is the only symptom experienced by the patient.

Immediately after the attack, *The Ophthalmoscope* shows a marked pallor of the papilla, while the artery and its branches are empty of blood, resembling fine white threads, and the veins are diminished in size at the papilla, but increase somewhat towards the periphery. Pressure on the eyeball produces no pulsation nor change in calibre of the vessels. Usually on the following day the central region of the retina begins to assume a greyish-white opaque appearance, consequent on disturbance of nutrition, in the midst of which the macula lutea is seen as a purple-red spot. The little blood contained in the vessels may soon be seen divided into short columns with colourless interspaces, and these move along the vessels with a slow jerky motion. Minute hæmorrhages often occur, most commonly between the macula and the papilla.

The peculiar appearance of the macula lutea is not due to hæmorrhage. According to Liebreich it is merely a contrast effect, the red colour of the choroid shining through where no nerve fibre layer is present. Leber suggests that the colour is due to the retinal purple.

The infiltration of the retina passes away in a few

weeks, and also the peculiar appearance of the macula lutea, while atrophy of the retina and papilla usually supervene.

Embolism of a branch of the central artery has been observed. In these cases the infiltration and the defect of vision are confined to the part of the retina supplied by the embolized branch.

Prognosis. Vision may improve for a time, but, when atrophy commences, it falls back again, and, finally, power of perception of light is lost. Cases of embolism of a branch are more likely to recover.

Causes. Endocarditis; mitral disease; atheroma of the large arteries of the body; aneurism of the aorta; pregnancy; Bright's disease. But it is said also to occur in healthy persons without any discoverable cause.

Treatment. Repeated paracentesis of the anterior chamber has been tried, and also iridectomy, with the object of reducing the tension, and in this way promoting a collateral flow of blood, by means of the only ascertained (Leber) communications between the retinal and choroidal vascular systems; namely, at the entrance of the optic nerve.* These attempts have been unsuccessful.

* Gowers (*Manual of Medical Ophthalmoscopy*, p. 31) is of opinion that there are other anastomoses between these systems, probably by connection with the long ciliary arteries. According to Nettleship (*Ophthal. Hosp. Rep.* Vol. IX. p. 161, and elsewhere) a cilio-retinal vessel, artery or vein, passing from the choroid or sclerotic at the papilla to the region of the macula lutea, is not an uncommon vascular anomaly; and Benson has published a case (*Ophthal. Hosp. Rep.* Vol. X. p. 336) in which the presence of such an artery seemed to have a favourable influence for the progress of the case, good central vision being recovered, although the field remained concentrically contracted.

Two cases are published, one by Wood-White * and another by Eales,† in which the circulation, which probably was not completely impeded by the embolus, was restored, and good vision regained, the recovery being probably due, as suggested by Wood-White, to the manipulations of the eyeball made in each case for the purpose of observing the effect of pressure on the vessels. So long as the pressure was maintained, a column of blood was being stored up behind the embolus, and on removal of the pressure rushed forwards against the impediment, carrying it into some more remote vessel, or into the general vascular system. In fresh cases, massage of the eyeball suitably applied would therefore always be worth the trial.

Thrombosis of the Retinal Artery. Blocking of the artery may occur spontaneously from thrombosis, due to failure of the heart's action and slowing of the arterial flow, the result of cardiac disease, spasm of the blood-vessels, disease of the walls of the vessels, or alterations in the quantity and amount of blood.‡

The *Ophthalmoscopic Signs* are in all respects similar to those of embolism.

Treatment. When transient attacks of blindness are complained of, it is important to overhaul the patient's general state, and to correct, so far as possible, any condition which might be the cause of feeble circulation. When the true attack comes on, manipulation of the

* *Ophthal. Rev.* 1882, p. 49.

† *Ophthal. Rev.* 1882, p. 139.

‡ See Mr. Priestly Smith's admirable article in Jan. and Feb. Nos. *Ophthal. Rev.* 1884, on Reflex Amblyopia and Thrombosis of the Retinal Artery.

eyeball applied immediately, or paracentesis of the anterior chamber, might prove of use.

Glioma of the Retina. This is a malignant growth which is found almost exclusively in young children, and may even be congenital. Owing to the age of the patients, the incipient stages of the disease are seldom observed, for they are unattended by pain or inflammation.

It commences as small white disseminated swellings in the retina, usually in one or other of the granular layers, more rarely in the nerve fibre layer. The retina is apt to become detached at an early period, but there are exceptions to this, especially when the disease starts from the nerve fibre layer. In the early stages there is no iritis, cyclitis, or opacity of the vitreous humour, and the iris-periphery is not retracted; points which especially enable us to distinguish it from pseudo-glioma (*vide* Purulent Inflammation of the Vitreous Humour, Chap. XVII. p. 307). Secondary glaucoma finally comes on. The optic nerve may become involved at an early period, but, sooner or later, it invariably does so, leading then to glioma of the brain. When the tumour has filled the eyeball, it bursts outwards, usually at the corneo-sclerotic margin, and then grows more rapidly and often to an immense size, as a fungus hæmatodes. The orbital tissues become involved, and even the bony walls of the orbit, while secondary growths in other organs, more especially the liver, are not rare.

Treatment. The only hope of saving the patient's life lies in enucleation at an early stage, or before the optic nerve becomes diseased. It is important, in removing the

eyeball, to divide the nerve as far back as possible, and, if the orbital tissues be already diseased, to remove all suspicious portions of them.

Blinding of the Retina by Direct Sunlight. This is especially likely to occur on the occasion of solar eclipses, by observation with unprotected eye.

Immediately after the exposure, the patients complain of a dark or semi-blind spot in the centre of the field of vision, a positive scotoma which may even be absolute, and which interferes with vision in proportion to the length of the exposure.

The Ophthalmoscope shows a small bright white spot at the fovea centralis, surrounded by a blood-red ring, which shades off into the normal colour. When the cases are not severe, improvement in vision takes place, but complete recovery is not common.

Czerny, and also Deutschmann,* showed, that concentration of the direct rays of the sun on the rabbit's retina gives rise to coagulation of the retinal albumen, vascular reaction, diapedesis of blood corpuscles, and pigmentary disturbances; and it is probable, that the changes in the human retina produced by exposure to direct sunlight are of similar nature.

This accident is not to be confused with snow-blindness.

Treatment. Hypodermic injections of strychnia, the constant current, and dry cupping on the temple afford the best chances for promoting the cure. Dark protection spectacles should be worn.

* *A. v. Graefe's Archiv*, Bd. XXVIII. p. 241.

CHAPTER XIX.

DISEASES OF THE OPTIC NERVE.

Optic Neuritis, also termed **Papillitis.** *The Ophthalmoscopic Appearances* of inflammation of the optic nerve vary a good deal with the intensity of the process. Common to every case is hyperæmia and swelling of the papilla, with haziness ("woolly" appearance) of its margins, and increase in the size of the central vein, while the central artery remains of normal dimensions or is contracted. The swelling and haziness extend but a short distance into the surrounding retina, and the distension of the vein is also not continued to the periphery of the fundus. In slight cases these appearances may barely exceed the normal, while in extreme instances the papilla is swollen to a great size and assumes quite a mushroom shape, the veins are enormously distended and tortuous, and the arteries contracted so as to be barely visible. Greyish striæ also extend from the papilla into the surrounding retina, some flame-shaped hæmorrhages are present on or near the papilla, and, occasionally, white spots in the retina, and a stellate arrangement of small white dots about the macula lutea produce an appearance which cannot be distinguished from albuminuric retinitis. This extreme form of papillitis is still often termed Congestion Papilla

(Choked Disc, *Stauungs-papilla*), although the theory which originally suggested the term has been abandoned.

The Vision, even in cases where the ophthalmoscopic signs are highly developed, is often but little below the normal, while in other, and possibly less well marked cases, it is reduced to perception of light, or even that may be wanting. These remarkable differences in the degree of blindness depend, probably, on the extent to which the nervous elements of the inflamed part are pressed on, or altered.

Pathologically, the changes in the papilla consist in venous hyperæmia, œdema, hypertrophy of the nerve fibres, infiltration of lymph cells, and development of connective tissue. Inflammatory changes, although less pronounced, are also present in the trunk of the nerve and its sheaths.

Causes. Inflammation of the optic nerve is most commonly found in connection with coarse encephalic disease.

Cerebral Tumours (including syphilomata, cysts, and abscesses,) in particular are the most common cause, and are, moreover, usually present, when the papillitis is of an intense kind (congestion-papilla). A very small tumour situated anywhere* in the brain is capable of producing optic neuritis, although unattended by meningitis.

Tubercular Meningitis is the next most common cause. Non-tubercular meningitis occasionally gives rise to optic neuritis, and sometimes, also, cerebro-spinal meningitis does so.

* Hughlings Jackson (*Trans. Ophthal. Soc.* Vol. I. p. 79), and Gowers (*Medical Ophthalmoscopy*, p. 127), state that optic neuritis has not been noted with tumours of the medulla oblongata.

The connection between Optic Neuritis and Intracranial Disease has not yet been clearly made out. In cases of tumour, as well as of tubercular meningitis, a considerable exudation of fluid usually takes place into the cavity of the third ventricle. This, along with the pressure of the new growth, or, alone in cases of meningitis, increases the intracranial pressure. By reason of the latter the subarachnoid fluid is believed to be driven into the subvaginal lymph space of the optic nerve, and to produce there that dropsy of the sheath which is found in nearly all these cases on careful post mortem examination. Schmidt-Rimpler* suggests, that it is pressure of this fluid on the optic nerve at its entrance into the eye, which gives rise to the papillitis, by impeding the return of venous blood from the retina. Leber puts forward the view,† that this fluid is probably an irritant, and as such sets up the inflammation. The latter, although most intense at the papilla, near which the fluid is collected in greatest quantity in the *cul de sac* formed by the termination of the intervaginal spaces at the papilla, is not confined to that place, as was believed, but extends up the trunk of the nerve, as microscopic examination reveals. Stephen Mackenzie,‡ Walter Edmunds,§ Gowers,‖ and Brailey¶ hold, that, in many cases at least, cerebritis recognizable only with the microscope is present, and that, an extension of this process down the optic nerve

* *A. v. Graefe's Archiv*, Vol. XV. ii. p. 193.

† *Trans. Internat. Med. Congress*, 1881, Vol. III. p. 52.

‡ *Brain*, Vol. II. p. 257.

§ *Trans. Ophthal. Soc.* Vol. I. p. 112.

‖ *Medical Ophthalmoscopy*, p. 70.

¶ *Trans. Internat. Med. Congress*, 1881, Vol. III. p. 111.

takes place. For they have ascertained, that the whole trunk of the nerve is involved in the inflammation, and they seem to regard the dropsy of the sheath as of little or no importance in the causation of the optic neuritis. The hypothesis which Hughlings Jackson* considers most plausible in cases of tumour is, that the optic neuritis is a doubly indirect result of the latter, his sequence of events being:—1. Tumour. 2. "Changes of instability" in its neighbourhood. 3. Vasomotor effects produced by the latter upon the muscular coats of the arteries of the optic nerves.

Other causes for Optic Neuritis are:—

Hydrocephalus. Here the pathogenesis is probably the same as in the foregoing, but the occurrence of optic neuritis is, on the whole, not very common in this connection.

Tumours of the Orbit. The path by which these growths bring about papillitis is still unknown.

Inflammatory Processes in the Orbit: such as caries, inflammation of the retro-orbital areolar tissue, erysipelas of the head and face extending to the orbital tissues, and periostitis. The presence of the latter may often be recognized by pain on motion of the eyeball, pain in the eye and forehead, and especially by pain on pressure of the globe backwards, and is often of rheumatic origin. In these cases the ophthalmoscopic appearances are apt to be very slight, and yet vision may be quite lost in a few hours or days, atrophy of the nerve then rapidly setting in.

Exposure to Cold, especially if the skin be heated and perspiring.

* *Trans. Ophthal. Soc.* Vol. I. p. 96.

Suppression of the Menstruation. If, during the menstrual period, the flow be arrested by exposure to cold, wet feet, etc., acute optic neuritis with rapid blindness may come on. Spontaneous amenorrhœa, or even irregularity of menstruation, and the climacteric period are liable to have a similar but more chronic result. Nothing is definitely known with regard to the connection between the uterine and ocular disorder, but it is believed that the latter is due to "determination of blood" taking place to the base of the brain instead of to the uterus. In these cases the ophthalmoscopic appearances, as well as the blindness, are apt to be extreme. Treatment should be directed chiefly to restoring the normal uterine functions. Hot foot-baths and Heurteloup's leech to the temples are of use.

Chlorosis. Here optic neuritis often is present, due to the disordered state of the blood, and usually yields under the influence of iron.

Syphilis. The trunk of the optic nerve may become the seat of specific inflammation in connection both with congenital and acquired syphilis. The ophthalmoscopic appearances may be normal (retro-bulbar neuritis), or may present any grade of neuritis even, to the most pronounced congestion papilla. In the latter case, it would not be possible to say, whether the papillitis be due to a syphilitic gumma within the cranium, or not. The inflammation often extends up to the chiasma.

Vision is usually much affected, and consecutive atrophy of the optic nerve is very liable to come on.

The treatment in these cases must be active mercuriali-

zation. According to Leber,* by this treatment, even if perception of light be lost for a period of not more than eight to fourteen days, hopes may be entertained of its complete or partial recovery. Later on, iodide of potassium is indicated.

Lead Poisoning. In some cases of lead poisoning, optic neuritis, not to be distinguished from that of primary cerebral affections, is found. Sometimes it is very slight, and again quite pronounced, the changes extending into the retina and simulating the retinitis of Bright's Disease, and, in such case, renal disease is likely to have much to do with the causation of the retinitis. Occasionally, optic atrophy is the first ophthalmoscopic appearance seen, but it is probably consecutive to retro-bulbar neuritis, as shown by white striæ (perivascularitis) along the vessels.

The vision is often much affected, and sudden complete blindness in connection with an intercurrent attack of lead colic may appear and pass off again. Consecutive atrophy is liable to come on, and then vision may be seriously and permanently damaged.

The diagnosis depends entirely on the presence of the other well known symptoms of lead poisoning, the ophthalmoscopic appearances presenting nothing pathognomonic.

The treatment is that for general lead poisoning.

Hereditary and Congenital Predisposition. Leber,†

* *Graefe und Sæmisch's Handbuch der Augenheilkunde*, Vol. V p. 823.

† *A. v. Graefe's Archiv*, Vol. XVII. ii. p. 249, and *Graefe und Sæmisch's Handbuch*, Vol. V. p. 824.

Mooren,* and others have observed that optic neuritis, without immediate cause, may attack several members of a family, and that the tendency to it may extend over several generations. It makes its appearance in these instances about the eighteenth or twentieth year of age, and confines itself almost exclusively to the male members. The patients may be perfectly healthy in all other respects, but many of them suffer from other affections of the nervous system. Both eyes are affected, the defect of vision being a central amblyopia, from which recovery is rare; but yet, although the ophthalmoscopic appearances become those of atrophy, the peripheral portions of the field retain their functions.

Mooren employs a seton in the back of the neck in the early periods, and later on nitrate of silver internally. Leber has found benefit from a mild course of mercurial inunction.

The two following diseases, Chronic Retro-bulbar Neuritis or Central Amblyopia, and Optic Neuritis with Persistent Dropping from the Nostril, must be treated of separately, owing to the well defined etiology of the one, and the peculiar symptoms of the other.

Chronic Retro-bulbar Neuritis, or **Central Amblyopia.** Until recently, it was not clearly known, whether these two terms should be applied to one and the same disease, or whether we had to deal here with two distinct processes. There is a class of cases, which were admittedly due to an inflammatory process in the trunk of the nerve, the causes and symptoms of which were

* *Ophthal. Bericht.* 1867, p. 305, and 1874, p. 87; and *Fünf Lustern Ophthal. Wirksamkeit*, 1882, p. 248.

very similar to those of central amblyopia; while there was strong presumptive evidence that the latter affection, often known as Toxic Amblyopia, was due to a retro-bulbar inflammation, but direct proof of the fact was wanting. Thanks to the investigations of Samelsohn,* and of Nettleship and Walter Edmunds,† there is now little doubt but that we have here to deal with only one disease.

Symptoms. The patient may complain of a glimmering mist which covers all objects, especially in a bright light, and the acuteness of vision is reduced. At the commencement, there is no defect in the field of vision, but a general dimness of vision. At a somewhat later stage, examination of the field discovers no defect for a white object; but, if a small pale green object be employed, it will generally be ascertained, that, at a region close to the point of fixation, the colour is not recognized, but seems grey or white, pink may seem blue, and red appear brown or black, while in other parts of the field the colours are recognized up to their normal boundaries. This is a central colour-scotoma. As the disease advances, a white object will be but indistinctly seen in the scotoma, and gradually all power of perception within its area may be lost, even the flame of a candle not being recognized. Hence the name Central Amblyopia. The scotoma is usually oval in shape, its long axis horizontal, and extends from the fixation point towards the blind spot, but occasionally it is of much larger dimensions.

Even when the scotoma is very pronounced, it remains

* *A. v. Graefe's Archiv,* XXVIII. i. p. 1.

† *Trans. Ophthal. Soc.* Vol. I. p. 124.

"relative," and is not observed by the patient as a dark spot in the field, differing thus from a scotoma due to disease in the outer retinal layers. The patients usually assert that they see better by reduced than in strong light. The affection is almost always binocular.

The Progress of the disease is slow, occupying weeks or months. Restoration of normal vision usually takes place, if the defect of vision, although of extreme degree, be not of old standing. In the latter case, while recovery of central vision cannot be expected, the functions in the periphery of the field are usually maintained.

Causes. With few exceptions the subjects of this disease are men, probably because their habits and modes of life expose them, more than women, to the influences which produce it. These are:—Exposure to cold and wet. Cold blasts on the body, especially the heated face (Samelsohn). The most common cause is excess in the use of alcohol or tobacco (toxic amblyopia), or of both; and the kind of alcoholic indulgence most likely to develope the disease is the frequent drinking of small doses of the stimulant. The individual who gets thoroughly drunk several times a week, is less liable to central amblyopia, than he who, without ever being incapable of transacting his business, takes many half-glasses of whisky or brandy during the day. Other signs of chronic alcoholism need not be present, but one often sees trembling of the hand and head, dyspepsia, sleeplessness, and even delirium tremens. The kind of tobacco most likely, when used in excess, to give rise to central amblyopia, is shag or twist. Other kinds of pipe tobacco and cigars may cause it, but I have not known of a case

due to cigarette smoking. Excess in alcohol is usually combined with excessive smoking, but cases of pure tobacco amblyopia certainly do occur, and are more common in Great Britain and Ireland than in Germany, where light cigars are more in use than the strong tobacco found here. Central amblyopia has also been observed in diabetes.

The Ophthalmoscopic Appearances are either quite normal; or, there is slight hyperæmia of the papilla and retinal vessels; or, in addition, there may be slight indistinctness of the margins of the papilla, and sometimes white striæ along the vessels, especially before they leave the papilla. Gradually, all the primary appearances, if any be present, pass away, and give place to a whiteness (atrophy) of the temporal side of the papilla, while the nasal portion remains of normal appearance, as also the vessels. At a very advanced stage, in some cases, the whole papilla presents the appearance of white atrophy.

The Pathological Changes (Samelsohn, Walter Edmunds) in the optic nerve consist in an interstitial neuritis at its axis, commencing at the optic foramen, and leading to proliferation of connective tissue and to secondary descending atrophy of a certain bundle of nerve fibres. These fibres are doubtless those which supply the region of the macula lutea. The changes are analogous to those which take place in the liver and brain as the result of chronic alcoholism.

Treatment consists, above all, in total abstinence from the poison in question. The patients are generally ready to promise this, and but rarely act up to their intentions. When they do so, improvement rapidly takes place in

most cases which are not too far gone, without any other treatment; but the cure may be promoted by the use of iodide of potassium in large doses, Heurteloup's artificial leech or dry cupping to the temples, hot foot-baths, and Turkish baths. Whatever remedy be used internally, care should be taken that it does not produce or increase dyspepsia, and it may be necessary to restrict the internal medicine for a time, or altogether, to a stomachic tonic. Sleeplessness should be met with chloral and bromide of potassium. Strychnine hypodermically ($\frac{1}{30}$ grain daily) is often of use. Treatment may have to be continued for some weeks, before an improvement in vision can be noted.

Optic Neuritis Associated with Persistent Dropping of Watery Fluid from the Nostril.

Nettleship* (one case), Priestly Smith† (two cases), and Leber‡ (one case) have placed on record four well observed cases of this remarkable disorder, and three others have been observed by Elliotson, Baxter, and Paget. These patients suffered from a persistent watery discharge from the nose (usually the left nostril), with more or less severe cerebral symptoms:—violent headache, epileptic attacks, vomiting, stupidity, sleepiness, unconsciousness, delirium, weakness of the lower extremities, and a high degree of amblyopia, or even blindness of both eyes due to papillitis followed by atrophy. In Leber's case, moreover, there was loss of smell, and in Nettleship's case palpitation of the heart and prominence

* *Ophthal. Rev.* 1883, p. 1.

† *Ophthal. Rev.* 1883, p. 4.

‡ *A. v. Graefe's Archiv*, XXIX. i. p. 271.

of the eyes. The fluid which ran from the nostril was, according to Leber, identical in its analysis with that of the cerebro-spinal fluid, while Nettleship and Priestly Smith found it to differ somewhat from that fluid. When, in P. Smith's case, it occasionally ceased to flow, the cerebral symptoms were brought on, or increased in violence. Leber's case was one of internal hydrocephalus, and he regards the fluid as coming from the third ventricle through a small opening in the ethmoid bone, while Priestly Smith and Nettleship consider the fluid as simply nasal, and due to the presence of small polypi, and do not try to account for its occurrence in connection with the cerebral and ocular symptoms.

The Prognosis for vision is bad, while the cerebral affection threatens even the life.

Treatment, which should be in conformity with the head symptoms, has not proved of use.

Atrophy of the Optic Nerve. This disease may be secondary to some other optic nerve or retinal affection, or, it may be a primary disease. The vision is seriously affected, and complete blindness is the usual result. With the ophthalmoscope the optic papilla is seen to have lost its delicate pink colour, and to have become white or greyish; while it is often cupped, and the vessels are apt to be diminished in calibre.

Atrophy of the Optic Nerve may result :—

1. *From Optic Neuritis.* The ophthalmoscopic appearances consist in a white or greyish-white colour of the papilla, with very diminished retinal vessels, and along both side of the vessels far into the retina are seen white lines, which sometimes even obscure the vessels and which

are due to hypertrophy of their coats. The diminution in calibre of the vessels is a sign of neuritic atrophy, but is not always present, and is moreover found with other forms of atrophy. Other signs of this form, also not constant, are, a certain opacity of the papilla, and that the lamina cribrosa is not generally visible owing to development of connective tissue at the papilla. It is, then, not always possible to recognize any given case as of neuritic origin.

Central vision is lowered, and, in addition, the field of vision becomes contracted, usually more at the nasal side. Subsequently, the temporal side of the field becomes contracted, and, finally, a small eccentric portion of the field to the temporal side may be all that remains, or, even this may disappear and absolute amaurosis result. The colour vision is always much affected.

2. *From Pressure.* This may be brought about by a tumour anywhere in the course of the nerve, by inflammatory exudations, by a splinter of bone in cases of fracture of the skull, and also by pressure upon the chiasma by the floor of the distended third ventricle in cases of internal hydrocephalus.

3. *From Embolism of the Central Artery of the Retina.* In these cases the contraction of the vessels is usually extreme.

4. *From Syphilitic Retinitis, Retinitis Pigmentosa, and Chorio-retinitis.* The vessels are much attenuated, and the altered colour of the optic disc is a dull yellowish hue, rather than white or grey.

5. *From, or rather associated with, Disease of the Spinal Cord (Spinal Amaurosis)*, especially locomotor ataxy. It,

more rarely, is found with insular sclerosis and lateral sclerosis. In general paralysis of the insane, although spinal disease is not always present, atrophy of the papilla frequently occurs. Optic atrophy is often an early symptom in locomotor ataxy, but it may not come on until the affection of the gait is well pronounced. It is probable* that the disease commences at the papilla. The ophthalmoscope displays a papery-white or bluish-white papilla, which in advanced stages often becomes cupped. The retinal arteries are usually extremely reduced in calibre, and the veins, too, may be small; but again the retinal vessels may differ but little, or not at all, from the normal.

Central vision is affected at an early stage in the disease, and eccentric contraction of the field usually appears at the same time. The contraction may be concentric, or it may be more marked in one direction than another, and opinion is divided as to the direction commonly first involved. This concentric contraction advances gradually towards the centre of the field from every side, until it finally engulfs the fixation point.

Occasionally the affection begins as a central scotoma, accompanied by eccentric defects of the field. Colour blindness is an almost constant symptom. As a rule, absolute blindness is brought about in the course of a year or two.

6 (and finally). Optic Atrophy, of the progressive form just described, may occur, *As a Purely Local Disease*, without any other defect in the system. The prognosis for the sight in such cases is as bad as that in spinal cases.

* Nettleship, *Trans. Ophthal. Soc.* 1883, p. 249.

Treatment. In neuritic atrophy, so long as there are still signs of active inflammation, antiphlogistic measures —Heurteloup's leech to the temple, hot foot-baths, rest of body and mind, dark room, iodide of potassium, and especially mercury internally when otherwise admissible —are to be adopted. At a later period, hypodermic injections of strychnia ($\frac{1}{30}$ gr. increased gradually to $\frac{1}{20}$ or $\frac{1}{15}$ gr. once a day) and galvanism may be tried.

In spinal amaurosis and in optic atrophy occurring as a local disease, strychnia hypodermically and the galvanic current sometimes improve vision for a time. Phosphorus internally may be given.

The treatment for optic atrophy, due to causes 2, 3, and 4, is to be directed to the primary disease.

The Prognosis is very bad, amaurosis being the ultimate result, as a rule; although every therapeutic measure may have been employed.

Tumours of the Optic Nerve. These are extremely rare. The chief forms are myxoma, glioma, and gliosarcoma or myxosarcoma.

The symptoms which von Graefe * held to be most characteristic of the presence of a tumour of the optic nerve were:—Increasing protrusion of the eyeball forwards and outwards, with retention of its motion, and without displacement of its centre of rotation. The tumour is soft, so that the eyeball can, as it were, be pushed back into it. Absence of pain.

The growth of these tumours is slow. It is sometimes possible to remove such a tumour, and yet to preserve the eyeball, by dislocating the latter during the operation.

* *Archiv für Ophthal.* X. i. p. 194.

As a rule, it is necessary to enucleate the eyeball in order to reach the tumour, and, if the growth have involved the surrounding orbital tissues, these, too, must be taken away.

Injuries of the Optic Nerve. In addition to those injuries which result from direct violence with sharp instruments, etc., entering the orbit, the optic nerve may be injured in falls on the head. Fractures of the base of the skull frequently involve injury to the optic nerve. But, even where no fracture occurs, blindness with atrophy of the optic nerve may come on, usually only in one eye, and in these cases concussion of the nerve at its passage through the optic foramen, or an extravasation of blood in the sheath of the nerve, is probably the direct cause of the atrophy.

Hemianopsia. This term is used for a class of cases, in which, owing to intracranial disease attacking the tractus opticus, or its central origin, or the chiasma, one half of the field of vision in each eye is blind.

Lateral homonymous hemianopsia is the most common form, and is due to a lesion involving a tractus opticus or its central origin. Most commonly, the boundary between the defective and seeing halves of the field is formed by a vertical line passing down the centre of the field. Sometimes this line lies a little to one side of the centre, and very frequently it circumvents the fixation point, so as to leave it free. Again, in some cases, there may be only a corresponding sector of one half of each field of vision defective.

Temporal hemianopsia is due to a lesion at the chiasma, involving those fibres of each optic nerve which go to supply the inner half of each retina.

Vision is disturbed in a minor degree, if only a sector of the field be destroyed. Temporal hemianopsia is less disturbing than the homonymous lateral form, and vision, in those cases in which the fixation point escapes, is less interfered with, than where it is included in the defect. Loss of the righthand side of the field is much more felt than that of the lefthand side, for the former is the one most necessary for fluent reading or writing.

Some cases of loss of the upper or lower halves of the fields of vision have been recorded.

The chief *Causes* of hemianopsia are cerebral apoplexy, and intracranial tumour.

The Ophthalmoscopic Appearances are at first normal, but, after a length of time, atrophy of the optic nerve may appear.

The Prognosis in cases of cerebral apoplexy is favourable; in so far, that the remaining portion of the field is always retained. No case has as yet been recorded in which it was lost by subsequent apoplectic attacks, but return of the functions to the affected side is rarely observed. If the case be a progressive one, such as a tumour, complete blindness may result by implication of the whole chiasma.

Treatment, of course, can only be directed to the primary disease.

CHAPTER XX.

AMBLYOPIA AND AMAUROSIS* DUE TO VARIOUS CAUSES.

Quinine Amaurosis. Quinine in large doses is liable to cause amblyopia, which sometimes amounts to total blindness. The latter is only temporary, but in severe cases concentric contraction of the field of vision may remain permanently, with some defect of central vision. Pallor of the optic papillæ, with scarcity and smallness of the retinal vessels, are the ophthalmoscopic appearances, when any are present. Hypodermic injections of strychnia, inhalations of nitrite of amyl, and general tonic treatment, are the means most likely to promote a cure.

Glycosuric Amblyopia. In addition to the retinal affections dependent upon diabetes, we recognize the occasional occurrence in that disease of defects of vision which are referred to disorder of the optic nerve, and which are not always accompanied by ophthalmoscopic changes. These defects of vision are found in the form of:—1. Central amblyopia, or, in still slighter cases, amblyopia without central scotoma. Occasionally, high

* The term Amblyopia indicates defective vision due to disease or functional disturbance of the retina or optic nerve, but with negative ophthalmoscopic appearances, or with signs only of optic atrophy. Amaurosis means total loss of vision, with similar condition of the ophthalmoscopic appearances.

degrees of amblyopia with concentric contraction of the field of vision, and yet negative ophthalmoscopic appearances, are present. 2. Atrophy of the optic nerve. This may appear in the usual form as progressive blindness, with concentric contraction of the field of vision; or, it may come on after the slighter form of amblyopia has existed for some time. It is probable (Leber) that these apparently different kinds of blindness depend upon similar pathological processes, and merely indicate degrees of the latter. What these processes are is still unknown, but the tendency to hæmorrhages in the retina in diabetes makes it likely that hæmorrhages in the optic nerve are the source of the amblyopia in question.

Amblyopia is sometimes the only symptom of diabetes, and consequently, as Leber points out, it is of the utmost importance to examine the urine for sugar in every case of amblyopia where the ophthalmoscopic appearances are negative, or where the only abnormality is atrophy of the optic papilla.

The Treatment indicated is solely that for the general disease, and the prognosis depends upon the amenability of the latter to treatment, and upon the extent to which organic changes in the optic nerve have gone.

Hæmorrhages from the Stomach, Bowels, or Uterus are capable of giving rise to serious and incurable blindness.

Blindness during, or immediately after a severe hæmorrhage is probably due to insufficient blood-supply to the nerve centres and retina, accompanying general exhaustion of the system. For such cases the prognosis is favourable.

But there is another class of cases, in which the defect of vision does not come on for from two to fourteen days after the hæmorrhage, and when the general system is recovering, in which the connection between the loss of blood and of sight is not yet clearly made out. Comparatively slight hæmorrhages, too, which caused no marked anæmia, are said to have been followed by blindness. Leber inclines to the belief, that this blindness is due to an extravasation of blood at the base of the skull and into the sheath of the optic nerve, but even then the relationship between this and the stomachic or uterine hæmorrhage is not made clearer. Papillitis has been several times noted with the ophthalmoscope in these cases; and this circumstance makes it probable that neuritis is the immediate cause of blindness, even in those cases which show no ophthalmoscopic sign of it. Hydræmia may be considered the poisonous influence which calls forth the neuritis.

The defect of vision may be but slight, or it may amount to absolute amaurosis. Both eyes are usually affected in equal degree; but cases have been observed in which one eye was completely amaurotic, while the vision of the other eye was quite normal. One such case is sufficient to prove that the lesion is peripheral; in fact, that it lies in each instance on the distal side of the optic chiasma. The field of vision is frequently contracted, either concentrically or segmentally, and even when central vision recovers the field may remain contracted.

The Ophthalmoscopic Appearances which are present immediately on the occurrence of the blindness, have not as yet been observed. A few weeks later they have been

found to vary in different cases. They have been found normal; or, presenting slight paleness of the papilla and contraction of the arteries; or, there was marked paleness of the papilla, and the arteries were extremely contracted with slight distension of the veins; or, paleness of the papilla was present, but its margins were indistinct and the surrounding retina somewhat swollen, while the retinal vessels were normal. Small hæmorrhages have repeatedly been found in the neighbourhood of the papilla. At later periods well marked optic atrophy is frequently observed.

Prognosis. If in the beginning the defect of vision be merely amblyopia and not complete blindness, hopes may be entertained of marked improvement or of complete recovery. But Mooren has seen slight amblyopia pass into amaurosis.

Hæmorrhages from the stomach are those which are followed by the most complete and permanent blindness, while uterine hæmorrhages are more commonly followed by less serious degrees of blindness.

The Treatment must consist in internal remedies calculated to correct the general anæmia, such as iron, beef tea and meat extracts, wine, etc. Strychnine hypodermically, to stimulate the nerve, may be employed.

Uræmic Amblyopia. This is most commonly seen in connection with the nephritis of pregnancy and scarlatina, but may occur in any case of uræmic poisoning. The blindness is usually absolute, and may come on suddenly, or with a short previous stage of dimness of vision.

The *Ophthalmoscopic Appearances* are negative.

Treatment can only be directed to the general condition.

The Prognosis for vision is good, as it always recovers when the patient's life is spared.

Reflex Amblyopia is observed chiefly in connection with irritation of the fifth pair, especially its dental branches. Carious molar teeth are its frequent cause; usually with severe toothache, but sometimes without it. The defect of vision may be confined to the side of the carious tooth, and is nearly always most marked on that side. It may be of extreme degree, even to the merest perception of light, but this is rare.

More frequently than amblyopia, as the result of toothache, are:—hyperæsthesia of the retina, photophobia, subjective sensations of light, and diminution in the amplitude of accommodation.

All these symptoms, even amblyopia of the severest type, disappear, when the dental affection is relieved.

Many cases are on record, in which wounds of the supraorbital nerve were looked on as the cause of amblyopia or amaurosis; but it is by no means certain, that an ophthalmoscopic examination would not have afforded another explanation in many of these cases.

Sympathetic Irritation is to be included under this heading. It is seen in the sound eye in some cases of cyclitis, and must not be confounded with sympathetic ophthalmitis, which comes about in quite a different way. Its symptoms are:—diminution of the amplitude of accommodation, asthenopia, hyperæsthesia of the retina, tearing, and subjective appearances of light.

Removal of the first eye, if otherwise indicated, always relieves sympathetic irritation.

The Ophthalmoscopic Appearances in reflex amblyopia are negative.

Hysterical Amblyopia. In hysterical individuals amblyopia is sometimes seen, either as the only symptom, or in combination with others. It takes various forms, *e.g.*, complete blindness, even to loss of perception of light; defective central vision, with concentric contraction of the field, or, with segmental peripheral defects in the latter; or, as central scotoma. The colour vision is often affected.

The *Ophthalmoscopic Appearances* are normal, and the *Prognosis* good.

Treatment must be directed to the general system.

Nyctalopia (Night blindness). This is a well recognised symptom of the disease known as Retinitis Pigmentosa (p. 326); but also occurs acutely, and without any ophthalmoscopic signs.

These patients can see well in good daylight, but of a very dull day, or in the dusk of evening, or by indifferent artificial light, their vision sinks very much more than that of persons with normal eyes. They are then unable to see small objects which are quite plain to other people, and in a still worse light they fail even to recognize large objects visible to every one else.

Conjunctivitis and xerosis of the conjunctiva frequently complicate acute nyctalopia. Recent investigations* have shown that micrococci and bacilli are the cause of the conjunctival affection in these acute cases, which are apt to be complicated with serious affections of other organs (kidney, liver).

* Leber, *Von Graefe's Archiv*, Vol. XXIX. part iii. p. 225.

The connection between nyctalopia and xerosis conjunctivæ remains to be explained. Acute nyctalopia is often the result of long-continued dazzling by very bright sunlight, or of lengthened exposure to bright firelight, *e.g.*, in foundries.

It is probable that in many, if not in most instances of this affection, defective nutrition of the system plays an important rôle in rendering the patients liable to it. Thus, in scorbutus acute nyctalopia has been frequently seen, when the patients have been exposed to strong glares of sunlight.

Treatment consists in protection from light, in fact in complete darkness for a time, and then gradual return to ordinary daylight; while the system is strengthened by careful dietary, and suitable tonic medicines.

Neurasthenic Asthenopia, or **Retinal Anæsthesia.** This peculiar affection, about which we have still much to learn, is a complex of eye symptoms in connection with a debilitated state of the nervous system, the eye itself being organically healthy. *These Symptoms* are :— 1. Diminished, but fluctuating, acuteness of vision. The effort or desire to see well is often the signal for the acuteness of vision to fall. 2. The rapid disappearance of objects from view, if looked at too long. 3. Attacks of defective sight, with positive scotomata coming on suddenly without provocation, and lasting for a few minutes. 4. Apparent contraction of the field of vision. If a perimetrical examination be made the field will be found contracted; but, as Wilbrand * has pointed out, this contraction is merely a sign of retinal exhaustion, as indi-

* *Archives of Ophthalmology*, XII. p. 429.

cated by the fact that the longer the examination is continued the more contracted does the field become. 5. Optical impressions are retained but a short time. The appearance of persons, places, etc., are not remembered when seen soon again. 6. Muscular asthenopia. Insufficiency of the internal recti is often present, as well as defective accommodation. 7. Hyperæsthesia of the retina. Dazzling is caused by even moderate light, and strong contrasts of light and shade are distressing, while the acuteness of vision is often improved when blue or smoked glasses are worn.

The Ophthalmoscopic Appearances are normal, or consist merely of some hyperæmia of the optic papilla.

The general symptoms of the condition consist in :—Insomnia; tinnitus; subjective sensations of hearing; exalted, or, again, defective sensations of taste and smell; sensations referred to the skin, such as formication, itching, burning, numbness, heat and cold; great restlessness of body; depression of spirits; want of mental energy; absentmindedness; weariness.

The persons in whom the affection is most common are children before and at the time of puberty, and women labouring under hysteria, anæmia, chlorosis, ovarian irritation, or displacement of the uterus: but it is also occasionally found in men.

Treatment. Any uterine or other local disorder must be relieved so far as possible. Rest of body and mind is to be enjoined, with fresh air and moderate exercise. Strychnine hypodermically is a valuable remedy in the affection, with which iron and quinine internally may be associated, and bromide of potassium with hyoscyamus

to promote sleep. In some, especially hysterical, cases valerianate of zinc is beneficial. Sea bathing, and cold shower baths, with change of air, are valuable adjuncts of the treatment. Blue or smoked protection glasses are most grateful to the patient, and promote the cure, but the spectacle frames often cause annoyance. Errors in refraction should be corrected.

The prognosis is favourable, inasmuch as ultimate recovery is assured, but the course of the affection is excessively chronic, extending over months or years, with frequent relapses.

Traumatic Anæsthesia of the Retina. A blow on the eye from a fist, cork from a bottle, etc., is liable to produce considerable amblyopia, with concentric contraction of the field, which may continue for a long time, while the ophthalmoscopic appearances are normal. Ultimately these cases usually recover, an event which may be decidedly promoted by the use of strychnine hypodermically; but very defective sight sometimes remains permanently.

Commotio Retinæ. Similar injuries give rise to a condition described under this name by Berlin. A whitish opacity is seen extending over a portion of the retina, usually in the neighbourhood of the macula lutea, or of the papilla. The vision is somewhat, not often seriously, affected, and the ophthalmoscopic appearances soon become normal.

Hyperæsthesia of the Retina. The symptoms of this affection are :—photophobia, tearing, and blepharospasm when the patient is exposed to ordinary daylight. There are no ophthalmoscopic signs. The chief causes

are :—hysteria, long-continued use of the eyes with very bright objects, and neuralgia of the fifth pair.

Treatment consists in removal of the cause, rest of the eyes, and protection from light, with suitable measures for the general health.

Snowblindness. Exposure of the unprotected eyes for a length of time to the glare from an extensive surface of snow produces dimness of sight, which may amount to almost complete blindness, but which usually passes off again as soon as regions free of snow are reached. One or two instances have been recorded in which the affection continued some days after the exposure, and then underwent recovery.

Pretended Amaurosis. Malingerers rarely pretend total blindness of both eyes, and such cases can only be detected by constant observation of their actions.

Pretended monocular amaurosis can generally be detected if the malingerer be made to look at a lighted candle placed some feet off, while a prism with its base downwards is held before the admittedly good eye. The malingerer will say he sees two images of the light, one over the other. Were he blind of one eye, he would not see two images.

Another method consists in holding a prism of some 10° or 12° with its base outwards before the pretended blind eye; when, if it sees, it will make a rotation inwards for the sake of single vision, an effort which a blind eye would not make.

Colour Blindness A certain proportion of people (3·5 per cent. of men, and less than 1 per cent. of women)

is congenitally colour blind in greater or less degree, without any other defect of vision.

From the point of view of the Young-Helmholtz theory, there are three kinds of colour-blindness, corresponding to the three colour-perceiving elements:—Red blindness, green blindness, and blue or violet blindness. If we imagine in Fig. 106, the curve of the red perception (R) erased, we can form some idea of the vision of a red-blind person. "The red rays of the spectrum which are capable of exciting but weakly the elements for green, and hardly at all the elements for violet, must appear to

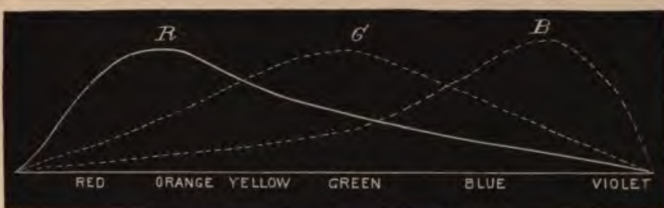


FIG. 106.

such a one as an intense but not very bright green, and all the more intense than the true green seems to us to be, because in the latter the other primary colours are mingled to some extent. Pale red, which is first perceptible to the normal eye, is unable to excite the elements for green in such an eye, and is seen by it as black. Spectral yellow looks like an intense bright green. Green compared with the foregoing will exhibit a mixture of the other primary colours, namely, a brighter but paler shade of the same colour than displayed by red and green. White light for the red-blind person is a mixture of their

two primary colours, in proportions which would appear to us to be greenish-blue"* (Helmholtz). If two of the curves are wanting, no power of distinction of colours can exist, and total colour blindness results. The absence of all three primary elements would, of course, cause absolute blindness for all light.

The Detection of Colour Blindness. The spectral colours are the most preferable for exact experiments, but the difficulty of producing them at every moment, and of combining them, renders them of little practical use.

The method commonly employed for the detection of colour blindness is that of Prof. Holmgren, of Upsala. The test objects used are coloured wools, of which a large number of skeins of every hue are thrown together. Test I. (*vide* inside of end cover) consists in presenting to the individual a pale but pure green sample, and requiring him to select out of the bundle of wools of all colours before him all those samples which seem to him to correspond to the test sample. If he does this correctly it is unnecessary to proceed further, the individual has normal colour sense. Amongst the skeins, however, there are some which are termed colours of confusion (greys, buffs, straw-colour), and if he selects one or several of these he is colour blind. If now we want to ascertain the kind and degree of his defect we proceed to, Test II*a*. A pink (mixture of blue and red) skein is given to be matched. If this be correctly done, we term the person incompletely colour blind. But if blue and violet, or one of them be selected, he is red-blind (sees only the blue in the mixture of blue and red). If he select green or

* Landois. Physiologie des Menschen, p. 816.

grey, or one of them, he is green-blind. In order to corroborate the investigation we may employ Test III*b*. A vivid red skein is given. The red-blind chooses, besides red, green and brown shades darker than the red, while the grey-blind chooses green and brown shades lighter than the red. In violet (or blue) blindness, purple, red, and orange will be confused in Test II*a*, but this is an extremely rare variety of colour blindness. Total colour blindness will be recognized by a confusion of all shades having the same intensity of light, and is also rare. The individual tested should not be allowed to name the colours, but merely to match them, as above described. It is impossible by this test for any colour blind person to escape detection. The congenitally colour blind are, as a rule, unaware of their defect.

Stilling has published Isochromatic Tables for the detection of colour blindness. Coloured letters are printed on a ground of a confusion colour, and, consequently, cannot be seen by the colour blind individual. Many prefer this method to Holmgren's.

Other methods are:—coloured shadows (Stilling, Cohn); simultaneous contrast (Weber, Pflüger); successive contrast (Schirmer, Cohn); Maxwell's revolving coloured discs (Woinow); coloured worsteds in rows on a card, some correct, others alternated with confusion colours, and these latter rows are pointed out as correct by the colour blind (Daae of Kagerö); rows of coloured spots on a black background, each row containing a varying quantity of grey, those with defective colour sense confuse the complementary colours in one row or in several (Bull, of Christiania).

CHAPTER XXI.

THE MOTIONS OF THE EYEBALLS AND THEIR DERANGEMENTS.

THE eyeball moves round a point on its antero-posterior axis, situated (in the emmetropic eye) 14 millimetres behind the cornea, and 10 millimetres in front of the posterior surface of the sclerotic. Its motions are effected by means of the six orbital muscles arranged in three pairs, each pair consisting of two antagonistic muscles; thus, the rectus internus and rectus externus are antagonistic, the former rotating the eye inwards, and the latter rotating it outwards. The remaining two pair are the recti superior and inferior, and the obliqui superior and inferior. The sixth cerebral nerve supplies the external rectus and no other muscle of the body, while the fourth nerve is for the special supply of the superior oblique, the other orbital muscles (as well as the sphincter iridis and ciliary muscle) being supplied by the third nerve.

The Primary Position of the Eyeball is that in which, the head being held erect, the gaze is directed straightforwards in the horizontal plane. This is the starting point from which the actions of the muscles are considered.

The Rectus Externus and Rectus Internus, lying from their origin to their insertion in a plane which corresponds

with that of the horizontal plane of the eyeball, move the latter on its perpendicular axis directly inwards and outwards, and have no other action.

The plane of *The Rectus Superior and Rectus Inferior* does not quite correspond with the vertical plane of the eyeball, and, consequently, the axis on which they rotate the globe is not its horizontal axis, but one which, passing from within and before, backwards and outwards, forms with the antero-posterior axis an angle of 70° (Fig. 107).

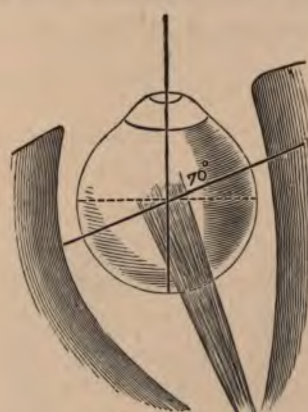


FIG. 107.

While, then, their action is mainly to rotate the eyeball upwards and downwards, these muscles rotate it also somewhat inwards. Moreover, the superior rectus giving to the vertical meridian of the cornea an inward inclination or inward wheel-motion of the eye (*vide infra*), while the inf. rectus gives this meridian an outward inclination or outward wheel-motion of the eyeball, the power of these muscles over the upward and downward motions is greatest

when the eye is turned out, for then their axis of rotation coincides most closely with the horizontal axis of the globe; and their influence over the wheel-motion is greatest when the eye is turned in, for then their axis coincides most closely with the antero-posterior axis of the globe.

The plane of *The Oblique Muscles* of the eyeball also approaches the vertical plane of the eyeball, the axis upon which they rotate the latter passing from within and behind, forwards and outwards, and making with the antero-posterior axis an angle of 35° (Fig. 108). The principal

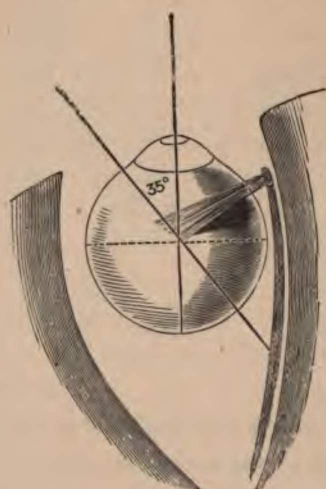


FIG. 108.

action, accordingly, of the oblique muscles is to incline the vertical meridian of the cornea; the sup. obl. inclines it inwards (wheel-motion inwards), the inf. oblique inclines it outwards (wheel-motion outwards). In addition to

this action the oblique muscles respectively rotate the eyeball downwards and outwards (sup. oblique), and upwards and outwards (inf. oblique). It is evident that the power of these muscles over the upward and downward motion of the eyeball is greatest if the eye be turned in, and that their power over the wheel-motion is greatest when the eye is turned out.

In dealing with the motions of the eyeballs we have to consider the motions of one eyeball as associated with those of its fellow; *e.g.*, the action of the internal rectus of the left eye is associated with the action of the external rectus of the right eye in rotation of both eyeballs to the right.

The vertical meridian of the eyes becomes inclined to the right or left in different positions of the globe, as has been experimentally proved by Donders.

1. In the primary position, as also when the eyes are turned directly inwards, outwards, upwards, or downwards, the vertical meridians (*a b*, Figs. 109–113) maintain their vertical direction (Fig. 109).

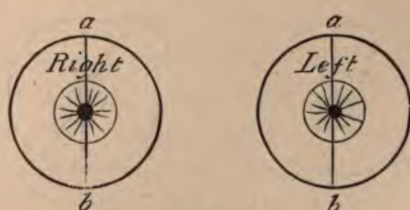


FIG. 109.

2. When the eyes are turned to the *left and upwards* the vertical meridian of each eye is inclined at the same angle to the left (Fig. 110). Wheel-motion to the left.

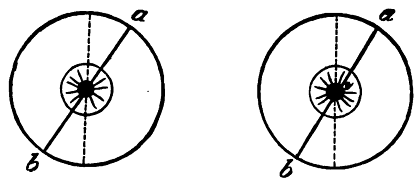


FIG. 110.

3. When the eyes are turned to the *left and downwards* the vertical meridian of each eye is inclined to the right at the same angle (Fig. 111). Wheel-motion to the right.

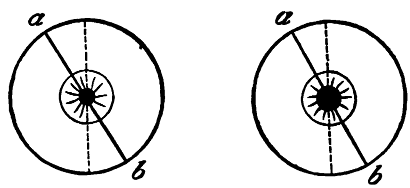


FIG. 111.

4. When the eyes are turned to the *right and upwards* the vertical meridian of each eye is inclined at the same angle to the right. Wheel-motion to the right (Fig. 112).

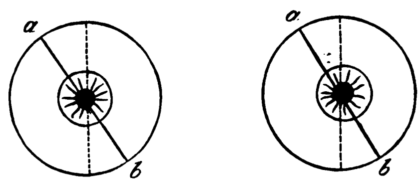


FIG. 112.

5. When the eyes are turned to the *right and downwards* the vertical meridian of each eye is inclined at the same angle to the left. Wheel-motion to the left (Fig. 113).

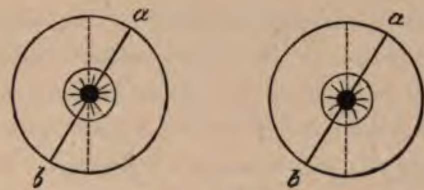


FIG. 113.

We shall now consider which muscles are called into action, when an individual requires to place his eye in the several principal positions.

1. *In the Primary Position* all the muscles are at rest.

2. Motion of the eyeball *directly outwards* is effected by the external rectus alone, and motion *directly inwards* by the internal rectus alone.

3. Motion of the eyeball *directly upwards* and *directly downwards* is effected chiefly by aid of the sup. and inf. recti. These muscles, however, acting alone rotate the eyeball slightly inwards, and give a certain inclination to the vertical meridian, which, in this position, should be upright. Consequently, in rotation of the globe directly upwards, the inf. oblique, which rotates the eye slightly outwards (as well as upwards) and inclines the vertical meridian outwards, must be associated with the sup. rectus in order to counteract in these particulars the tendency of its action. In rotation of the eyeball directly downwards the inf. rectus must be associated with the sup. oblique which acts antagonistically to this rectus in respect of rotation inwards, and outward wheel-motion.

4. Rotation *upwards and outwards* is chiefly effected by aid of the rectus superior and rectus externus. But the

latter muscle has no influence over the wheel-motion, while the former produces wheel-motion inwards. The inclination, however, of the vertical meridian is outwards in this position; and, therefore, a third muscle, which will supply this inclination in a high degree, is required, namely, the inferior oblique, whose power over the wheel-motion of the eyeball is greatest, when the latter is in this position.

5. Rotation *downwards and outwards* is chiefly effected by the rectus inf. and rectus ext. Inasmuch, however, as the former inclines the vertical meridian outwards, while the latter has no influence over it at all, a third force is required, which will bring about the required inward wheel-motion, namely, the sub. oblique, whose influence in this respect is most powerful when the eye is in this position.

6. Rotation *upwards and inwards* is chiefly brought about by the rectus superior and rectus externus. The effect of the former, however, upon the inward wheel-motion of the eye would be so great as to interfere with parallelism of the vertical meridians of the two eyes, that of the other eye not being inclined outwards in a corresponding degree. A third force, therefore, is required, which will to a certain extent counteract the influence of the sup. rectus in this respect, and this is the inf. oblique, which in this position of the eyeball has but slight power over its wheel-motion.

7. Rotation *downwards and inwards* is chiefly the result of contraction of the rectus inf. and rectus int. The power of the former over the outward inclination of the vertical meridian would, in a similar way, be too

great, and must be similarly corrected by the action of the superior oblique.

Paralysis of the Orbital Muscles.

General Symptoms. 1. Diplopia. The affected eye being deviated from its correct position, and being more or less incapable of associated motions with the other eye, the image of the object looked at is not formed on identical spots of the retina in each eye, and hence the object seems doubled. 2. Indistinct Vision. If the paralysis be but slightly marked, diplopia may not be present, but the double images overlapping each other cause dimness or confusion of sight. 3. Giddiness, due partly to the diplopia and partly to faulty projection of the object. 4. Patient turns the head to one side to diminish or eliminate the diplopia. 5. Patient closes one eye to procure single vision.

In studying a case of paralysis of an orbital muscle, the following general principles should be borne in mind. 1. The defective mobility and the diplopia increase towards the side of the affected muscle, *e.g.*, towards the left, if the left external rectus be paralysed. 2. The secondary deviation (*i.e.*, the deviation of the sound eye while the affected eye fixes) is greater than the primary deviation (*i.e.*, the deviation of the affected eye while the sound eye fixes). Because the muscle in the sound eye, which is associated in its action with the paralysed muscle in the affected eye (*e.g.*, the rect. int. with the rect. ext.), must receive a nervous impulse of equal intensity to that

sent to the weak muscle, and as the latter requires a considerable impulse to excite its action, its associate will be over-excited. Let us suppose the left external rectus to be paralysed, and that, shading the right eye with a hand, we require the patient to fix with his left eye an object held somewhat to his lefthand side; we may notice, on removing the shading hand, that the right eye has been rotated inwards to a degree far exceeding that of the

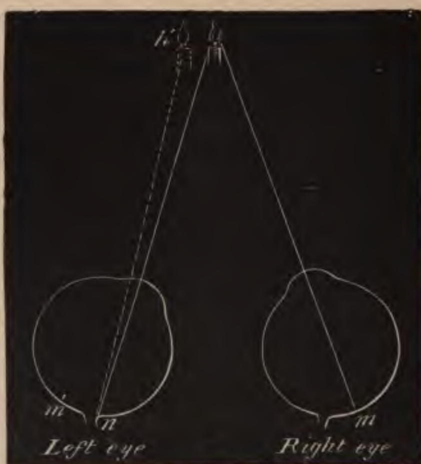


FIG. 114.

primary deviation of the left eye, and has now to make an outward motion in order again to fix the object. 3. The image formed on the retina of the affected eye is projected (seems to lie) in the direction of the paralysed muscle. *E.g.*, If the left ext. rect. be paralysed, the image of that eye will be formed to the inside (at *n* Fig. 114) of the macula lutea (*m*), and will therefore seem to

lie to the left (at h') of the image belonging to the right eye. Where the image of the affected eye lies to the corresponding side as in this instance, the diplopia is termed homonymous, and such double vision always indicates convergence of the visual lines. If the internal rectus of the left eye be paralysed, the image on the retina of that eye falls to the outside of its macula lutea, and must, therefore, be projected to the right of the true position of the object; this is crossed diplopia, and must always attend divergence of the visual lines.

Paralysis of the External Rectus of the Left Eye. If this be complete or considerable it is easy of diagnosis, as marked loss of power of motion of the eyeball outwards is present, and the patient complains of double vision. He keeps his head turned to the left, in order to diminish the influence of the paralysed muscle as much as possible. If, however, the paralysis be but slight, the patient may not complain decidedly of diplopia, but only of indistinctness or confusion of sight, especially when he looks towards the left. To decide the diagnosis in such a case the double images must be examined. A long lighted candle is used as the object to be looked at; and the affected eye is covered with a bit of red stained glass, in order to differentiate the image belonging to it. The candle is now held on a level with the patient's eyes and straight opposite him at about three metres distance (eyes in primary position). In this position the candles are seen very close together, or overlapping each other, the red candle to the left, the white to the right (homonymous diplopia = convergence). If the candle be carried slowly to the right, the patient

following it with his eyes while his head remains fixed, the images come still closer together, or only one candle is seen. But, if the candle be carried to the patient's left-hand side (direction of the paralysed muscle), the images go farther apart, their relative position being maintained. The images are erect, as no wheel motion is caused by action of the external rectus. If, however, the candle be held to the left and raised aloft, the image belonging to the left eye will seem to lean over towards that of the right eye (Fig. 115). The reason of this is, that, owing

FIG. 115.

to the paralysis of the external rectus, there is now no possibility of single vision, and consequently no reason, in the interest of single vision, for a modification by the inferior oblique of the tendency which the superior rectus has, in this position, to incline the vertical meridian outwards. The vertical meridian of the affected eye will therefore incline outwards more than formerly, and all vertical images belonging to that eye will seem to incline in the opposite direction, when compared with images of the sound eye. An analogous derangement of the vertical meridian takes place in the position below and to the outside.

If the patient be told to direct his gaze specially towards the red candle, the distance between the two

candles will be much greater, than if he direct his gaze towards the white candle. This is explained by General Principle, No. 2, p. 375.

If the patient's good eye be closed, and an object (surgeon's finger) be held up within his reach, but towards his lefthand side, and he be requested to aim rapidly at it with his forefinger, he will aim to the left of it. The nervous effort sent to his left external rectus, to enable him to turn the eye towards the object, is of such intensity as to lead him to fancy that the object lies much further to the left than it does (incorrect projection of the field of view); for we, to a great extent, estimate the distance of objects from each other by the amount of nervous impulse supplied to our orbital muscles in motions of the eyeball.

A prism held horizontally before the affected eye with its base outwards brings the double image closer together; or, if the correct prism be selected, the images will be blended into one.

Paralysis of the Superior Oblique of the Left Eye. This paralysis will be most apparent when a demand is made for motion of the eyeball downwards and inwards, motion in this direction being that over which the superior oblique has most influence. Still, absolute defect of motion is sometimes difficult to detect even in complete paralysis of this muscle, owing to vicarious action of the inferior rectus and internal rectus. Careful examination of the secondary deviation will often be successful as to this point, but it is the examination of the double images upon which we must chiefly depend for the diagnosis.

In the whole of the field of vision above the horizontal plane there is single vision. Below the horizontal plane in the median line diplopia appears, the image of the left eye standing lower than that of the right, because the superior oblique being a muscle which assists in rotating the eye downwards, the latter, for want of the action of this muscle, now stands higher than its fellow (right eye), and, consequently, images on its retina will not fall on the macula lutea (as they do in the right eye) but above it, and will therefore be projected below the image of the right eye. The superior oblique assists also in rotation of the eye outwards: therefore, loss of this power must commit the eyeball to a certain extent to the power of the muscles which move it inwards, and a rotation in this latter direction (convergence) takes place, with the result of making the image of the left eye stand to the left of the image of the right eye (homonymous diplopia). The superior oblique inclines the vertical meridian inwards: therefore, in rotation directly downwards, loss of its power commits the eye to the outward wheel motion imparted to it by the inferior rectus. This gives to the image belonging to the left eye an inclination to the right. The position downwards and inwards of the eyeballs is that in which the greatest demand is made upon the superior oblique for rotation of the eye downwards: therefore, it is in this position its want for this purpose is most felt, and when the candle is held in this position, the vertical distance between the double images is greatest. The power of the superior oblique to incline the vertical meridian inwards is greatest when the eye is turned downwards

and outwards; consequently, in this respect its paralysis will be most felt in this position, and therefore here the inclination of the red candle to the white most marked.

A remarkable phenomenon usually noticed in this paralysis (and sometimes in paralysis of the inferior rectus), and for which a good explanation does not exist, is, that the image belonging to the affected eye seems to stand nearer the patient than that of the sound eye. To sum up then: (*vide* Fig. 116) below the horizontal plane

FIG. 116.

there is homonymous diplopia, while the image (A) of the affected eye stands on a lower level, is inclined towards the other image, and seems to be nearer the patient.

In an extreme lower and outer position, the image of the affected eye may sometimes seem to stand higher than that of the sound eye, owing to an excessive outward inclination of the vertical meridian, which throws the image on the lower and outer quadrant of the retina. In order to do away with or diminish the diplopia, the patient inclines his head forwards and turns it to the side of the good eye. For the prismatic correction of the diplopia two prisms will be required, one with its base

downwards to correct the vertical difference, and a second with its base outwards to correct the lateral difference.

Paralysis of the Internal Rectus, Superior Rectus, Inferior Rectus, Inferior Oblique, and Levator Palpebræ. These muscles, as well as the sphincter iridis and ciliary muscle, are all innervated by the third nerve, and may be paralysed singly or in any combination. As regards the three recti and the inferior oblique, what has been said concerning their actions, the motions of the eyeballs, and the diagnosis of paralysis of the external rectus and superior oblique will enable the reader to comprehend the symptoms attending their paralyses. Ptosis is, of course, the one and striking symptom of paralysis of the levator palpebræ, while paralysis of the sphincter iridis and of the ciliary muscle are treated of in other chapters. (Chaps. II. p. 50, and XIV. p. 243.)

Complete paralysis of all the branches of the third nerve produces a remarkable appearance. The upper lid droops, the pupil is half dilated and immovable, the power of accommodation is destroyed, and the eyeball is often slightly protruded, owing to the backward traction of those recti being lost to it. Motion inwards exists to but a slight degree, and motion downwards is effected only by aid of the superior oblique, and is accompanied by marked inward wheel-motion. If the paralysis be of some little standing, the external rectus obtains rule over the eyeball, and rotates it permanently outwards.

Ophthalmoplegia Externa is complete paralysis of all recti and oblique muscles of both eyes, as well as of both levatores palpebrarum ; but, as a rule, the sphincter

iridis and ciliary muscle remain intact. This peculiar and rather rare affection may come on suddenly, or it may make its appearance very slowly, or in periodic exacerbations.

Conjugate Paralysis consists in loss of power of motion of the two eyes in some one direction, *e.g.*, to the left (which would imply loss of power in the left external rectus and in the right internal rectus), to the right, upwards, or downwards. This condition accompanies other paralyses or symptoms indicating intracranial disease, but may be the only diseased appearance. In four cases recorded by Hunnius,* post mortem examination showed the lesion to be situated in the pons varolii. Graux† and Duval‡ have demonstrated the existence of fibres passing from the nucleus of the sixth nerve, under the corpora quadrigemina, and joining with the fibres of the opposite third pair for the supply of the internal rectus of that side. The sixth nerve of one side supplying in this way the external rectus of its own side, and, to a slight extent, the internal rectus of the opposite side. It is quite probable that similar decussations may exist in the nerve supply of the other orbital muscles, which would assist in explaining their conjugate paralyses. Although in these cases the power of motion to the right or to the left may be wanting, yet convergence of the visual axes can be effected.

* *Aus der Med. Abthlg. des Kölner Bürgerhospital.* Bonn, 1881. *Centralbl. f. pract. Augenheilkunde*, 1881, p. 490.

† *Soc. de Biologie de Paris*, 23 Nov. 1878; *Centralb. f. pract. Augenheilkunde*, 1879, p. 32.

‡ *Progrès Méd.* 1879, No. 28; *Centralbl. f. d. med. Wissensch.* 1879, p. 813.

The cerebral centres for these two kinds of actions are therefore distinct.

The Causes of Paralyses of Orbital Muscles are peripheral or central. The first are chiefly of rheumatic or syphilitic nature.

Rheumatic paralysis, to which the external rectus is specially prone, will be noted, if there are symptoms of general rheumatism, or if there is a history of exposure to cold or wet immediately preceding the attack.

Syphilis will be suggested as a cause, if there be a specific history, and that other causes can be excluded. Syphilitic paralyses of the orbital muscles are amongst the later symptoms of the disease, and may be due to exostoses or gummata at the base of the skull, or to syphilitic neoplasms in the course of the nerve. Other neoplastic growths can, of course, cause these paralyses in the same way.

After an attack of diphtheria paralyses of the orbital muscles is not uncommon.

The diagnosis of a central cause depends chiefly upon collateral symptoms, *e.g.*, paralyses of other nerves, headache, loss of memory, etc. Frequently, as pointed out by von Graefe, a diagnostic sign may be obtained from the diplopia itself; for, when of central origin, coalition of the double images by means of prisms is difficult or impossible, the slightest motion of the patient's head or eyes, or of the prism, being sufficient to separate the images widely.

Experience shows, that complete paralysis of any one of the nerves supplying the orbital muscles, if unaccompanied by other paralyses, rarely depends upon a central cause;

but that, if the latter exist, the loss of nerve power is only partial. This, no doubt, is due to the fact that, unless the central lesion be very extensive—in which case other nerves will be involved—all the filaments of the nerve in question cannot be implicated; while, at the base of the skull or in the orbit, any nerve or branch can be singled out by a comparatively circumscribed morbid process. In the premonitory stages of tabes dorsalis, ephemeral partial paralyses, affecting now one and again another of the orbital muscles, may sometimes be observed. In some cases of ophthalmoplegia externa, *post mortem* examination has discovered disease (inflammatory changes, hæmorrhages) on the floor of the fourth ventricle and of the aqueduct of Sylvius.

Conjugate paralysis is probably due to a lesion at the cerebral centre for the associated movements or co-ordination of the eyeballs. Schiff places this centre in the posterior portion of the corpora quadrigemina. Adamük places it in the anterior portion.

Prognosis. If the cause be central, the prognosis, I need hardly say, must be very cautiously given. If it be peripheral, recovery is very frequent; much, however, depending on the nature of the lesion. In cases where a cure is not effected, the antagonist muscle often becomes contracted, and the eye is then rotated permanently and excessively in the corresponding direction. In cases of old standing, a permanent contraction of the muscles of the neck may be brought about from the inclination of the head which the diplopia has obliged the patient to adopt.

Treatment. When the cause is peripheral, the medical treatment consists in drugs suitable to the fundamental

disease (rheumatism, syphilis, etc.). Local depletion at the temple in the early stages, and galvanism later on, may be employed with advantage.

Prismatic glasses may be used, either to eliminate the diplopia, or to excite the weak muscle to exert itself. In the former case the glass selected must completely neutralize the diplopia; but, as it can do so only for one position of the eyes, prisms are rarely employed in this way. In the latter case, a prism slightly weaker than that sufficient completely to neutralize the diplopia is selected; in order that, with a little effort, the weak muscle may be enabled to bring about single vision, and, this effort having been successfully maintained for some days, a still weaker prism is prescribed, and so on.

It is very important for the patient's comfort, while awaiting his cure, that the affected eye should be covered, so that the distressing double vision may be obviated.

Surgical treatment is justifiable only when other means have failed to restore muscular equilibrium. If the deviation amount to 3-4 mm., tenotomy of the antagonistic muscle, with subsequent tenotomy of the associate muscle in the other eye, will be sufficient; but, if the deviation amount to 5 or 6 mm. advancement of the paralysed muscle in addition to the tenotomy may be required. This surgical treatment applied to the internal and external rectus gives satisfactory results, but in case of the superior and inferior recti it is not so satisfactory, while the oblique muscles should not be operated on.

Advancement of a Muscle. (Internal or External Rectus.) If it be desired to advance the insertion of the paralysed external rectus of the right eye towards the

cornea, the proceeding commences with tenotomy of the internal rectus. A curved needle is then threaded with a rather long silk suture, and the latter is drawn through to half its length, and two other needles are threaded one on either end of the same suture. The tendon of the external rectus is then divided in the usual way, and seized, along with the conjunctiva lying over it, in a toothed forceps, one blade of the instrument being placed between muscle and sclerotic,

FIG. 117. (*de Wecker.*)

the other blade on the outside of the conjunctiva. The central needle is then passed through muscle and conjunctiva from within outwards (Fig. 117). One of the other needles is now passed from the conjunctival wound under the conjunctiva, and 3 to 4 mm. above the upper margin of the cornea, until it reaches a point some millimetres to the inside of the vertical meridian of the eye, where the point is passed through the conjunctiva. The other

needle is passed in the same way below the cornea. The central needle is now cut off, and thus two distinct sutures are formed. The two ends of one suture are now drawn tightly by the surgeon, and simultaneously his assistant ties the two ends of the other suture. By this means the tendon of the ext. rectus is drawn well forwards. The further back the central needle is entered through the tendon the greater the effect produced, but the immediate effect should be much more than that ultimately required. An immobilizing bandage is applied, and the sutures allowed to remain twenty-four to forty-eight hours. In performing this operation de Wecker's double strabismus hook for seizing the muscle to be advanced, is a useful instrument.

Advancement of the internal rectus with tenotomy of the external rectus is indicated, in cases where tenotomy of the former muscle for convergent concomitant strabismus has been performed, and where the result has been excessive, with secondary divergence. This occurrence is rarer now than formerly, when the belly of the muscle, not merely the tendon at its insertion, used to be divided.

The old plan of advancing a muscle by dividing it, and then tying the eyeball over in the corresponding canthus (by a suture fastened to the bridge of the nose in the case of the internal rectus), is now no longer employed.

Convergent Concomitant Strabismus.

When treating of the Relative Amplitude of Accommodation (Chap. I. p. 11) I said, that with each degree of convergence of the optic axes a certain effort of accom-

modation is associated. The greater the angle of convergence the greater is the effort of accommodation.

Of this physiological fact the hypermetrope often unconsciously takes advantage. In order to brace up his accommodation in an excessive degree for the sake of distinct vision, he increases the angle of convergence of the optic axes by rotating one eye (Fig. 118 L) somewhat

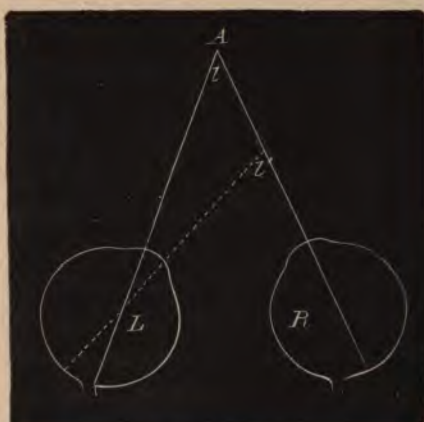


FIG. 118.

inwards. The angle l' is thus made larger than the angle l, and the effort of accommodation normally belonging to the angle l' is obtained, and the right eye (R) directed to the object A receives, consequently, a clear image of it on the retina.

Convergent strabismus usually appears in early childhood, when small objects, such as toys and pictures, begin to be closely observed, or perhaps a little later, when the first lessons are being learned; in short, when the accommodation begins to be called into action more continuously.

It is at that time generally *periodic*, occurring only when some great effort of accommodation is required. Later on, when these efforts occur more frequently and are more sustained, the strabismus usually becomes permanent in one or other eye; but, in a small percentage of cases, the squint remains periodic.

In *alternating strabismus* the patient squints sometimes with one eye and sometimes with the other. This is commonly developed from the permanent monolateral form, in consequence of the patient preferring to see objects situated to the side of the non-squinting eye with the squinting eye, *e.g.*, if the left eye be the squinting eye, it is used for looking at objects on the patient's right hand side. This practice brings about contraction of the right internal rectus and debility of the right external rectus, which makes it difficult for that eye to move towards its own side, and it comes to be used only for objects at the patient's left hand side. The alternation in the use of the eyes is advantageous, as it serves to keep the retina of each in good order (*vide infra*).

The amount or degree of the deviation from the normal position may be estimated in two ways:—

1. By the linear method, *i.e.*, by the number of millimetres which the eye deviates from its normal position. The patient being directed to fix his vision on a distant object straight in front of him, and the strabotometer (Fig. 119) being applied to the lower lid of the good eye, so that the *o* point may coincide with a perpendicular let fall from the centre of the cornea, the number of millimetres from this point to the inner angle of the eye are read off; say 13 mm. The strabotometer is now applied to the squint-

ing eye in the same way, and the number of millimetres from the centre of the cornea to the inner angle read off; say 8 mm. The difference between this latter distance and that in the healthy eye gives the amount of the deviation, *i.e.*, 5 mm.

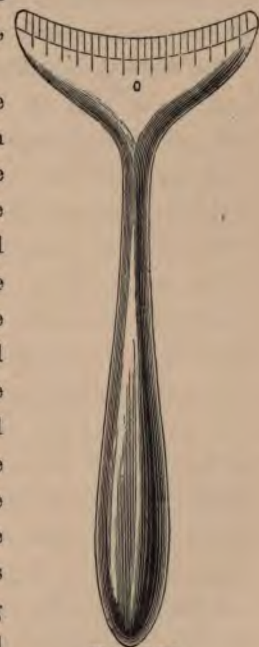


FIG. 119.

2. By the Angular Method. The end here aimed at is to ascertain the size of the angle which the visual axis of the squinting eye makes with the direction it should normally have. For this purpose a perimeter is employed.* The arc of the instrument being placed in the horizontal position, and the patient's head adjusted, he is told to look at a distant object on the prolonged central radius of the perimeter. The visual axis of the sound eye will be directed to this point, but that of the squinting eye will cut the line of its normal visual axis at a point this side of the visual object, and will form with it a certain angle, which is the angle of the strabismus. The greater the latter the greater the angle. The size of this angle is found as follows:—While the patient maintains his gaze in the position just described, the flame of a candle is passed along the arc of the perimeter, until it comes to a point at which its reflection lies in the centre

* Mr. Priestly Smith's perimeter is unsuitable for the examination.

of the deviated cornea. This gives us the optical axis of the eye, which for our purpose is practically the same as the visual axis. The number of degrees of the angle of strabismus can be read off on the perimeter scale at the point where the flame stands.

This method of estimating the degree of strabismus has been much used by Landolt. It may seem a more scientific method than the linear, but I do not know that it affords more accurate data for a proposed tenotomy, or that it is in any way more practically useful.

The form of strabismus which we are considering is termed *concomitant*, because the squinting eye follows the straight one in all its movements to an equal extent. Starting from the median position the parallelism of the optic axes is defective, and as the eyes are moved from side to side, this defective parallelism continues the same in direction and degree, neither increasing nor decreasing. Moreover, if the straight eye be shaded and the squinting eye by this means obliged to fix the object of vision, say the surgeon's finger held up in the median line, it will be found that the straight eye is now squinting inwards. This deviation of the good eye is called the secondary deviation, and, in these cases of concomitant strabismus, is equal in degree to the primary deviation of the squinting eye. This is an important point, for it is a chief aid in the differential diagnosis of this form of strabismus from the paralytic form. (See Gen. Prin. No. 2, p. 375.)

As a rule, these patients do not see double, and the question will naturally be asked, Why is this? The image of the object looked at, it will be said, must be

formed in the squinting eye on a part of the retina not identical with that in the straight eye, but lying to the inside of it; and, hence, the image of the object should be projected by the squinting eye to its own side of the true position of the object (homonymous diplopia), and the latter should therefore be seen doubled. The only reasonable answer which can be afforded to this question is, that the form of strabismus with which we are dealing being to a certain extent a physiological process, the mind involuntarily suppresses the perception of the image belonging to the squinting eye, in a manner analogous to that by which, when we are deeply interested in conversation, all extraneous sounds are unperceived, although they, too, must reach the nerve of hearing. This suppression of the image belonging to the squinting eye is probably aided by the indistinctness of the image itself, which is formed on a peripheral part of the retina, while in the good eye it falls on the macula lutea. We often find, too, that the squinting eye is *ab initio* more defective than its fellow (macula cornea, higher degree of H, astigmatism, etc.), and doubtless such defect is often the factor that determines which will be the squinting eye; a somewhat defective organ being the one most easily spared, and in which the image may be most easily suppressed.

Yet, in a small percentage of cases double vision does exist, and in a larger proportion it can be produced, if the acuteness of vision of the squinting eye be sufficiently good. To produce diplopia in these cases, the patient is directed to look at the flame of a candle some 3 m. distant, and a bit of violet glass is held before the straight

eye so as to diminish the brilliancy of the image on its retina, and then the patient may see double; or, a prism with its base turned outwards may be held before the squinting eye so as to throw the image near its macula, and thus diplopia is produced.

The evils of strabismus are much greater than mere disfigurement and loss of expression of the face. The sight of the squinting eye, even if previously good, becomes defective from want of use, the seat of this defect lying in the retina and optic nerve. There are three stages of this amblyopia ex anopsiâ. 1. The general power of vision of the retina is diminished. In this stage the separate exercise of the eye in reading, perhaps with help of a magnifying glass, is often of benefit. 2. The predominance in acuteness of vision of the yellow spot over other parts of the retina is lost, and hence an unsteadiness of fixation results, the eye feeling about, as it were, for a part more sensitive than the rest. 3. Only the inner part of the retina from the macula lutea is capable of perceiving objects, so that, even when the other eye is closed, the squinting eye does not rotate outwards to fix centrally.

In neither of these latter stages does treatment give a satisfactory result as regards improvement of vision, although the ophthalmoscope may discover no pathological change in the fundus oculi.

Treatment. Theoretically, the wearing of spectacles for the complete correction of the hypermetropia should remove a strabismus. In practice this is rarely so. It may be, that if, at the very first appearance of a strabismus, the hypermetropia were fully corrected, and the spectacles

constantly worn, the deformity might disappear. But parents rarely bring their children for advice at this period, and, moreover, the wearing of spectacles at so young an age would be attended with evident risk. When, however, a periodic strabismus comes under our care, it is always worth while to attempt its cure by paralysing the accommodation with atropine for a number of weeks, and prescribing the correcting glasses for the hypermetropia to be worn for distant vision, and a suitably higher number for reading, etc. After a time the atropine may be discontinued, while the correcting + glasses are still worn; and, occasionally, after some months, complete and permanent parallelism of the visual axes will by this means be obtained. As a rule, however, the treatment is useless, a fact which is due, probably, in some cases to an association of the habit of squinting with the effort to see distinctly. In confirmed permanent strabismus there is no prospect of such a cure.

Orthopœdic Treatment. This is occasionally used for the purpose of diminishing a strabismus, or of curing some cases, or of making the prospects of an operative proceeding more promising. That it may be carried out, it is necessary that binocular vision should exist; *i.e.*, diplopia, or the possibility of producing it, as above. Should the absence of diplopia depend on defective vision in the squinting eye, an improvement may be brought about by separate exercising of the eye with large type, etc. When binocular vision (diplopia) has been established, we ascertain what is the weakest prism which, with its base outwards, will bring the double images of the candle at 4 m. into one, and then dividing it in two (*e.g.*,

if it be prism 8° it is divided into 4°, base outwards, for each eye), we prescribe it in spectacle form to be worn constantly for three weeks. Weaker prisms are then given, and so on until the deviation is completely overcome. Prisms of more than 6° before each eye cannot be prescribed owing to their weight and to the colour effects they produce.

The stereoscope has been employed for this mode of treatment, the patient being required to combine the two fields of vision, which are brought just close enough to enable him to do so with a slight effort. After some exercises the fields of vision are removed from each other a little so as to require a greater effort, and so on until the normal distance is attained, which implies parallelism of the visual axes.

Very few cases are either cured or relieved by this orthopœdic treatment, because few cases are suitable for it for want of binocular vision, and it requires much patience and intelligence on the part of the patient. As an after-treatment, when tenotomy has been performed, it is of more use.

Operative Treatment. Division of the Tendon of the Internal Rectus Muscle is the measure which has to be applied to a majority of the cases which come under our notice. It is absolutely contra-indicated in periodic strabismus only.

Before proceeding to operate, two points of great importance are to be noted, viz.:—the presence, or otherwise, of binocular vision; and the degree of the outward mobility of the eye. If binocular vision exist, as it rarely does, the prospects of an accurate readjustment are

increased. Still more important is the mobility of the eye outwards—the efficiency of the external rectus—for unless this muscle be sufficiently active, tenotomy of the internal rectus is apt to have little or no result, the eye-ball not being drawn outwards by its antagonist. Such loss of power of the external rectus is often present, particularly in cases of some standing and in alternating strabismus. The extent of motion of the eye outwards and inwards should be compared with that of the good eye; and it will always be found, that the outward motion is decreased and the inward motion increased; but, if the outward motion be decreased in a marked degree, we must be prepared to put in a suture to increase the effect of the operation (*vide infra*), *i.e.*, to supplement the external rectus in its effort to roll the eye outwards.

By detaching the tendon of the internal rectus from the sclerotic at its insertion into the latter, the tendon, provided the external rectus retains sufficient power, is caused to become attached to the globe further back, where its mechanical influence over the inward motion of the eyeball is less. Such a change in the position of the insertion of the internal rectus must be accompanied by loss of power of motion of the eye inwards. But this defect is partly covered by the above mentioned excessive motion inwards; and, moreover, a slight loss of power of the internal rectus is readily compensated by a motion of the head, when objects very much to the side of the operated muscle are to be looked at. But, if the loss of power of the muscle produced by the operation be too great, a want of symmetry in the actions of the internal recti for convergence of the visual axes and in the

associated motions of the eyes towards the side of the operated muscle will become apparent. In high degrees of strabismus, which cannot be corrected (*i.e.*, the tendon cannot be caused to move back far enough) without giving rise to marked loss of power of motion of the eye inwards, the difficulty is overcome by dividing the effect of the operation between the two eyes. If, for example, there be a strabismus of 8 mm. in the left eye, 4 mm. of the deviation may be corrected by a tenotomy in that eye, while the remaining 4 mm. are corrected by a tenotomy of the internal rectus in the right eye. By this means each internal rectus is weakened to an equal degree, and the symmetry of the motions of the eyeballs, maintained. If the deviation does not amount to more than 4 or 5 mm. it may be corrected by a tenotomy on the squinting eye alone.

It is possible to regulate the operative procedure so as to produce the required effect according to the degree of deviation. The rules which guide us in this respect were laid down by v. Graefe,* and have not been modified in any important particular.

The tendon is attached to the sclerotic, not merely by its direct insertion, but also indirectly by connective tissue between its under surface and the sclerotic, by connective tissue between its upper surface and the conjunctiva, and by connective tissue processes which it derives from the capsule of Tenon where it pierces the latter.

In performing tenotomy for strabismus it is always necessary to divide every fibre of the true attachment of

* *Archiv f. Ophthal.* Vol. III. pt. i. p. 177.

the tendon. The greater effects, in varying degrees, of the operation are produced by the more or less extensive division of the indirect attachments of the tendon.

The instruments required for this operation are, a spring-stop speculum, a small toothed forceps, a blunt scissors somewhat curved on the flat, and a large and small strabismus hook (Fig. 120). I frequently do the operation without an anæsthetic, as it is rapid and not very painful; but, if the patient wishes for it, I always put him under the influence of ether.

FIG. 120.

The patient being placed on his back, the surgeon stands in front of him and on his left hand side, if the left eye is to be operated on; or behind him, if it be the right eye. The speculum is then inserted, and the conjunctiva over the insertion of the tendon of the internal rectus is seized with the forceps, and incised with the scissors between the forceps and the eye. Into the opening thus made the points of the closed scissors are inserted, and with a snipping action a passage is made through the subconjunctival tissue from the conjunctival aperture to the upper border of the tendon in the left eye, or to its lower border in the right eye. The scissors are then laid aside, but the conjunctiva is still held in the forceps, while with the right hand the point of the larger hook is passed through the opening and along the passage until the edge of the tendon is reached. It is then turned rapidly round and under the tendon, and the hook is brought close up to the insertion of the latter into the sclerotic, care being taken that the whole

breadth of the tendon lies on the hook. The forceps are now laid aside, and the hook carrying the tendon is transferred to the left hand. One blade of the scissors (held in the right hand), is now inserted between the globe and the tendon, and the latter is completely divided at its insertion. The smaller hook is then employed for searching above and below for any strands of the tendon which may be left undivided; the test for complete division being, that the hook can be brought up without obstruction to the margin of the cornea. If the smallest segment of the tendon be left undivided, the result of the operation is apt to be unsatisfactory. Immediately after the operation a marked inability to move the eye inwards should be examined for; as this motion can now only take place by aid of any remaining connective tissue attachments of the muscle to the eyeball and capsule of Tenon. If this defect in motion be not present, or in only slight degree in comparison with the supposed extent of operation, it may be concluded that the tendon is imperfectly divided, and a new search for undivided filaments must be made. To estimate this loss of motion, it is necessary before the operation to note the degree of mobility of the eyeball inwards, and to compare it with the inward motion of the other eye.

It is important that the examination of the mobility of the eye just after operation should not be undertaken until the patient recovers from the anæsthetic, as under its influence a tendency to divergence of the visual axes is present.

An operation such as I have described will correct a strabismus of 3 to 4 mm. (and of 18° angular measure-

ment) in an adult, provided the external rectus is sufficiently powerful. With a normally-acting external rectus an effect of even 5 mm. might be produced, if an extensive loosening of the subconjunctival connective tissue be made. In children the effect is some 1–2 mm. greater than in adults.

An effect of less than 3 mm. may be produced by drawing the edges of the conjunctival wound together with a suture, the tendon being thus prevented from uniting with the globe so far back. The more conjunctiva we include in the suture at each side of the wound, the more will the effect of the tenotomy be reduced. This restricting suture should also be applied, when the immediate result of the tenotomy is greater than expected or desired.

Another means at our disposal, for diminishing the effect of the operation, consists in causing the patient to look towards the side of the tenotomized muscle for two or three days afterwards. This can be effected by aid of a pair of goggles with an opening only towards the side to which the patient is to look.

If an increase in the effect of the operation be desired, a more extensive division of the indirect connections of the muscle with the sclerotic may be performed. The patient also may be made to look to the opposite side from that of the tenotomized muscle for some days, thus causing the tendon to become inserted further back. But, if a decided increase in the effect be desired, it is most surely obtained by a conjunctival suture at the outer part of the globe. The point of a needle carrying a silk suture is entered through the conjunctiva close to the outer corneal

margin in the horizontal plane of the eye, and passed on between conjunctiva and cornea until it nearly reaches the external canthus, when it is passed out through the conjunctiva. The closure of the suture draws the enclosed portion of conjunctiva into a fold, with the effect of rolling the eyeball outwards. The suture is left lying for two or three days, when the internal rectus will have become re-attached. The greater the fold of conjunctiva included in the suture, the greater is the effect of the latter.

As the edges of the conjunctival wound cannot be accurately adjusted with sutures, none are applied for that purpose. They are only used, as above, to diminish the operative effect; or, when an extensive loosening of the subconjunctival tissue has been performed, to prevent sinking of the caruncle. Some operators, it is true, employ them with every tenotomy as a matter of routine.

The immediate and ultimate effects of a tenotomy are by no means identical. Immediately after the operation the effect is very marked, owing to the loosening of the tendon from its insertion. In a few days, when it becomes re-attached, the effect diminishes, and in the course of some weeks there is again an increase in the effect, and this increase continues for about a year, as above stated.

The ultimate result may be estimated immediately after the operation, by testing the power of convergence. If the patient be directed to look with both eyes at the surgeon's finger held in the middle line, and it be approached to within 12–15 cm. of his nose, and if the convergence of the eyes can be maintained at that

distance, the effect will not be too great. But if, at a distance of from 18 to 20 cm., the operated eye ceases to converge, or begins to diverge, or if even at 12 cm. the convergence, although accomplished, cannot be maintained for more than a few moments, and that then the operated eye deviates outwards, ultimate divergence may be expected, even though the actual position of the visual axes be correct. A restricting suture must be applied in such cases.

Sometimes, although the patient converges up to 12 cm. satisfactorily, and maintains the convergence at that distance for some moments, the eye will then rotate inwards. In such cases there is danger of a recurrence of the strabismus, which we must combat with convex glasses, exercise of the binocular vision, the use of prismatic glasses, etc.

In every case of convergent concomitant strabismus, in which the deviation measures 5 to 6 mm. or more, its correction should be effected by a tenotomy on each eye. The insufficiency of the internal rectus is in this way distributed between the two eyes. For example:—If the deviation amount to 6 mm. a tenotomy is performed as above to correct 3 mm. on the squinting eye. Correcting glasses for the hypermetropia are prescribed to be worn constantly, and in the course of fourteen days a tenotomy is performed on the non-squinting eye, which will enable it to rotate outwards and come into parallelism with the squinting eye. With such a deviation, it is well to restrict the effect of this second tenotomy by means of a suture, so that not more than 2 mm. of the remaining strabismus may be corrected—for at least 1 to $1\frac{1}{2}$ mm. of

convergence should in each case be left behind. The reason for this is, that the effect of a tenotomy of the internal rectus increases to that extent within twelve months, then to become permanent. If complete parallelism be present a week or two after the operation, divergence is apt to appear in the course of a year.

It is unwise to tenotomize the internal rectus of each eye at one sitting, unless the convergence amount to more than 8 mm. For myself, I do not under any circumstances divide each muscle at the same sitting, but prefer the safer course of ascertaining the result of the first tenotomy, and after fourteen days applying such an operation to the second eye as will correct the remaining strabismus.

The subconjunctival operation for strabismus, proposed by the late Mr. Critchett, is performed as follows:—A fold of conjunctiva is seized, close to the lower margin of the insertion of the muscle, and incised with a blunt-pointed scissors so as to expose the tendon. A strabismus hook is passed through the opening and under the tendon. The scissors is now inserted and opened slightly, one point being kept close to the hook while the other is passed between the tendon and the conjunctiva, and the tendon is divided close to its insertion. This method is very generally adopted by English surgeons. For myself, I prefer the operation (von Graefe's) previously described, as it much more readily admits of modifications of the effect.

The operation for strabismus is dangerless. It is never followed by inflammatory reaction, and the results obtained from it are most satisfactory.

Sometimes a small granulation appears at the conjunc-

tival wound after a week or more. It should be snipped off with a scissors, not touched with a caustic, and does not reappear. Occasionally, a small arterial branch may be divided during the operation, and this, bleeding into the capsule of Tenon, may cause rather alarming exophthalmus. The protrusion goes back in a few days with use of a pressure bandage. I have only seen this occurrence twice.

Sinking of the caruncle, when it does rarely occur, can be remedied in the following way:—The conjunctiva is divided vertically about 6 mm. from the caruncle. The inner lip of the wound is raised, a scissors curved on the flat passed in, and the subconjunctival tissue as far as under the sunken caruncle separated. The subjunctival tissue under the outer lip of the wound and as far as the corneal margin is loosened in the same way, and the two flaps are brought together with a suture, which includes a sufficiency of conjunctiva to draw the caruncle well forwards.

The after-treatment consists in the wearing of a bandage for two or three days, or, if a suture has been applied, until its removal. After this, if the effect of the operation has been as anticipated, the spectacles for correction of the hypermetropia should be worn constantly. If the effect be greater than desired, the spectacles may be omitted, and the patient directed to use his eyes a good deal for near work; or, the hypermetropia may be only partially corrected. In this way a certain amount of strabismus is again encouraged, by calling the accommodation into play.

I prefer not to operate on children under five years of

age, as the danger of wearing spectacles before that is too great. When younger children are brought, it is, I think, best to postpone the operation, advising the parents in the meantime to blindfold the straight eye for an hour twice a day, in order to oblige the child during that time to use the squinting eye, and thus preserve its retinal functions in good order.

Insufficiency of the Internal Recti-Muscles.

In the normal condition, the orbital muscles are in a state of equilibrium, no one muscle, or pair of muscles having more power over the eyeballs than its fellow.

Insufficiency of the internal recti muscles implies a disturbance of this equilibrium. The internal recti in these cases are so much weaker than the external recti, that the former are obliged to make a constant effort to prevent the eyes, or one of them, from becoming divergent, and it is only the demand for single vision which stimulates the muscles to this effort.

Muscular asthenopia is the symptom caused by this insufficiency. The patients complain that, after using their internal recti in reading, writing, sewing, or other near work for a time, they begin to find the objects spreading, becoming indistinct, and perhaps doubled. Pain in and about the eyes comes on. These symptoms gradually increase, until the work has to be discontinued.

The diagnosis of the condition can be made certain by the following methods. The patient is directed to look at the tip of the surgeon's finger held up in the middle

line. The finger is brought slowly closer to the eyes until a certain point is reached where the internal rectus of one eye ceases to act, the other eye still remaining in fixation. The first eye, upon the finger being advanced a little more, usually becomes divergent.

Or, if the tip of the finger be held some 20 cm. from the patient's eyes, and if, with his other hand, the surgeon cover one of the eyes, say the right, while the left is caused to fix the finger-tip, it will be found that the eye under the hand is diverging, and, when the hand is removed from it, it makes an inward motion, in order again to fix the finger-tip. The explanation of this is, that, when one eye is covered, there is nothing to be gained in the way of single vision by an excessive exertion of the weak internal recti; and, consequently, the eye which is excluded from the act of vision, is abandoned to the control of the over-strong external rectus, and only returns to its normal position, when, being restored to participation in the act of vision, diplopia would otherwise be present.

The best and most accurate test is the following:—A dot with a line drawn vertically through it (Fig. 121) on a sheet of white paper is given to the patient to look at, at his usual reading distance. Before one eye, say the right, a prism of about 10° with its base downwards is held vertically. This, in a normal eye, would produce a double image of the dot, so that the figure would seem to be a line with two dots, the upper dot being the image belonging to the right eye. In insufficiency of the interni the image of the right eye would not only

FIG. 121

be higher than that of the left, but it would also stand to the left (crossed double images) more or less, so that here the picture is that of two lines each with a dot, the upper line and dot standing to the left hand side (Fig. 122). This crossed diplopia indicates divergence. The explanation of the experiment is as follows:—When a prism is held before the right eye, the possibility of single vision is removed, and, insufficiency existing, the weak internal rectus of the right eye has no object in greatly exerting itself, and consequently abandons the eye to the traction of the external rectus. Hence the divergence and projection of the image of this eye to the opposite side.

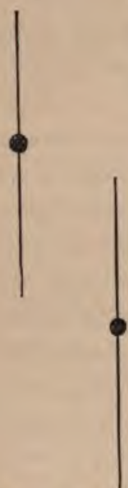


FIG. 122

The degree of insufficiency existing may be determined by this same experiment. If a weak prism be held with its base inwards before the left eye, in the above case, the images of the lines will appear to be brought closer. By gradually increasing the power of the prism, one will be found which brings the lines together, so that the picture will now be that of two dots over each other on one line. This prism is the measure of the insufficiency.

Insufficiency of the internal recti is a common attendant upon myopia (p. 34), and in that form of refraction is more likely to be troublesome than in emmetropia or hypermetropia, owing to the necessarily close approximation of objects to the eyes. Probably it is to a certain extent congenital, like the myopia, and is further developed

by the constant demand for the effort of convergence. In myopia not only does insufficiency cause asthenopia, but it acts injuriously by promoting posterior staphyloma, owing to the excessive straining of the muscles.

Treatment. In moderate degrees of myopia, the use of such concave glasses as will permit the patient to read at 35 cm. distance may relieve the asthenopic symptoms.

Decentration of these glasses may give further aid. If the glasses be so set in the spectacle frame, that their centres are on the outer side of the visual lines, the inner half of the glasses act as prisms with their bases inwards (Chap. I. p. 2), and by them the rays are broken inwards, *i.e.*, towards the macula lutea in each eye, so that a slight divergence may take place without diplopia, etc. In this way the internal recti are relieved. Should the case be one demanding the use of convex glasses (hypermetropia, presbyopia) the decentration must be inwards.

A more perfect and accurate method is that of prescribing prisms, bases inwards, to be worn for reading and other near work. These may be combined with concave or convex glasses where such are indicated. The prism which is the measure of the insufficiency (see above) is divided between the two eyes. If it be 4°, a prism of 2° is placed base inwards before each eye for near work. Very high prisms cannot be ordered, owing to the colour effects they produce; and, in cases where they would be required, the insufficiency can be only partially corrected.

Operative Treatment. This consists in weakening the too strong external rectus by tenotomy. The danger

of the method is, that convergent strabismus with homonymous diplopia for distant objects may result, unless the case be suitable for operation. Only those cases are suitable, in which absolute divergence of the visual axes is present; or, in which, with a prism of not less than 10° base inwards before one eye, the flame of a candle at 3 m. distance is seen single, or if perhaps doubled for a moment, then becoming single. When, with such a prism, single vision is present, the external rectus by an effort must have overcome the effect of the prism, and it is admissible to deprive the muscle of the power represented by that effort or prism. If diplopia be produced by a prism of 10° the tenotomy is contraindicated, for the effect of the latter could not be modified to the slight power of abduction indicated by a weaker prism. A source of error in the ascertaining of this abduction prism which must be guarded against is, that the patient may suppress the image of one eye, and that his single vision may be merely due to the fact that he is seeing with the other alone. The higher the abduction prism the more extensive may be the division of the subconjunctival tissue, etc., while with weak abduction the effect must be diminished by a conjunctival suture.

Immediately after the operation there should be a certain amount of convergence, as shown by homonymous diplopia in the middle line for the flame of a candle at 3m. distance. This convergence, or diplopia, should not be greater than can be corrected by a prism of 10°. Moreover, if the candle be moved from the middle line 15° to the opposite side from the operated muscle (to the right if the left external rectus has been tenotomized) there

should be no convergence (no diplopia), and a vertical prism before one eye should only cause double images placed directly over each other. If by these experiments it is shown, that the operation has produced an excessive effect, the latter must be diminished by a suture drawing the lips of the conjunctival wound together, and including more or less conjunctiva according to the excess to be corrected. Or, if a suture has already been applied, and the result be still in excess, it must be withdrawn, and a still more restricting suture inserted. In all these cases, convergence must of course be present when the candle is carried over to the side of the operated muscle; this disappears—except perhaps at the very most extreme position on that side—as also the convergence in the middle line, by reason of cicatricial contraction at the new insertion of the tendon; always provided, that the indications for the operation and its performance, as above set forth, have been accurately attended to.

NYSTAGMUS.

This term indicates an oscillation of the eyeballs from side to side (the most common form), in the vertical direction, or rotatory (caused by the oblique muscles). It is most commonly found with congenitally defective vision, microphthalmus, coloboma of the choroid, in albinos, etc., but it may be acquired, and is often seen in those employed in certain mines on the Continent. The imperfect power of fixation, the macula lutea not being preferred above any other part of the retina for central fixation, is in these cases one factor in the causation of

the nystagmus. Probably some disturbance in the muscular equilibrium is another.

Those patients in whom nystagmus is due to a congenital defect of vision, do not complain of oscillation of the objects they look at, but individuals who become affected with it in later life are much troubled with that symptom.

Treatment is unsatisfactory in its results. Improvement of the acuteness of vision by separate exercise of the eyes, and correction of any anomaly of refraction should be tried. If strabismus be present, it should be corrected, after which a diminution in the oscillations may result.

CHAPTER XXII.

DISEASES OF THE ORBIT.

Inflammation of the Connective Tissue of the Orbit. *The Symptoms* of this affection are:—Erysipelatous swelling of the lids, especially of the upper lid; serous chemosis; pain in the orbit, increased on pressure of the eyeball backwards; violent facial neuralgia; exophthalmus, with impairment of the motions of the eye in every direction; and high fever.

Vision is not generally affected, but sometimes it is so from optic neuritis, and then, too, mydriasis is seen. The cornea is often anæsthetic, or partially so.

The surgeon, by pressing the tip of his fourth finger between the eyeball and the margin of the orbit, may feel a more or less resistant tumour. This gradually increases in some one direction, the integument in that position becomes redder, and fluctuation pronounced, and the abscess finally opens through the skin or into the conjunctival sac. Restoration to the normal state usually comes about, but in some cases complete atrophy of the optic nerve supervenes.

Causes. The inflammation may be idiopathic, or exposure to cold, etc., may be the only assignable cause. It may be due to:—Perforating injuries of the orbital tissue, or the lodgment of foreign bodies in the orbit.

Erysipelas of the eyelids. Septicæmia after surgical operations, etc., or in metria. Periostitis of the orbit, and, according to Berlin,* hypopion keratitis.

Treatment. Locally, poultices or warm fomentations, and when pus has formed its earliest possible evacuation, by preference from the conjunctival sac. The general constitutional treatment suitable to each case need not be discussed here.

Capsulitis, or **Inflammation of the Capsule of Tenon,** is an affection concerning the occurrence of which there is some doubt.† Its symptoms are said to be:—Moderate exophthalmus; pain accompanying the motions of the eyeball; indistinct fluctuation around the eyeball; and some chemosis and subconjunctival injection.

It may be due to injuries of the capsule (as, very rarely, in strabismus operations), or to exposure to cold.

Treatment. Warm fomentations. Evacuation of pus if it should form. Constitutional measures.

Periostitis of the Orbit. Acute periostitis has many symptoms in common with phlegmonous inflammation of the orbital connective tissue, which generally accompanies it, but may usually be distinguished from the latter inflammation occurring independently, by the fact, as first pointed out by the late Mr. John Hamilton of Dublin,‡ that in it pressure on the orbital margin is painful. The absence of this tenderness, however, is not always conclusive of the absence of periostitis, especially when the latter is restricted to the deep parts of the

* *Graefe und Sæmisch's Handbuch*, Vol. VI. p. 521.

† Berlin, *Graefe und Sæmisch's Handbuch*, Vol. VI. p. 534, etc.

‡ *Dublin Journal of Medical Sciences*, 1836.

orbit. In periostitis the eyelids are not usually so swollen as in inflammation of the orbital tissues. Suppuration may take place, necrosis in consequence of detachment of the periosteum come on, and communications with the neighbouring cavities be formed.

Periostitis of a more chronic form, and without tendency to suppuration, occurs most commonly in persons with a constitutional rheumatic tendency. It is accompanied by pain in and about the orbit, and there is increased tenderness on pressure of the eyeball backwards. Exophthalmus and all other outward signs are usually wanting.

The Prognosis depends much on the seat of the inflammation. If this be in the deep parts of the orbit, thickening of the periosteum may cause permanent protrusion of the eyeball, extension of the inflammation to the optic nerve may result in optic atrophy, the orbital muscles or the nerves which supply them may be implicated with consequent paralysis, or, finally, the periostitis may strike into the meninges of the brain. When the inflammation is near the margin of the orbit, early evacuation of pus, if it has formed, reduces the process within safe bounds; and this position is one of less danger in respect of its surroundings.

Causes. Periostitis of the orbit may be caused by blows or other traumata, by extension from neighbouring cavities, by syphilis or rheumatism.

Treatment. Warm fomentations. Exit given to pus if possible. Constitutional measures.

Caries of the Orbit is very frequently the result of periostitis, but often commences in the bone. It may

attack any part of the orbital walls, its favourite seats being the margin above and to the outside, or below and to the outside. When it is seated deeply in the orbit, it often causes exophthalmus and pain. At the margin it produces œdema and swelling of the eyelids with conjunctivitis, and, suppuration coming on, the abscess opens through the integument or conjunctiva. A fistula is apt to remain for a length of time, and, the skin being drawn in to this, ectropion of the lid is produced. If a portion of dead bone come away, the resulting cicatrix is liable to maintain the ectropium (pp. 153, 154).

The chief cause of caries of the orbit is struma. Traumata may also give rise to it.

Treatment. The evacuation of purulent collections at the earliest possible moment—if deep in the orbit, by the careful introduction of a long bistouri—the insertion of a drainage tube, and the regular syringing of the cavity with antiseptic solutions, until no more rough or bare bone can be felt with the probe.

Injuries of the Orbit. Wounds of the soft parts in the supra-orbital region, involving the supra-orbital nerve, were formerly believed to be capable of producing a reflex amaurosis, and many such cases have been recorded under the name of supra-orbital amaurosis. By the light of modern physiology and ophthalmology it is not probable, I might say not possible, that any such reflex could take place, and it can hardly be doubted that the blindness in those recorded cases was brought about in some other way, *e.g.*, orbital periostitis, concomitant injury to the eyeball itself, facial erysipelas, intracranial lesions, and so on.

Perforating injuries of the orbit through the eyelids by prods of walking-canes, etc., and the lodgement of foreign bodies in the orbit are serious accidents. They are liable to be followed by phlegmonous inflammation, or, if a pointed weapon (stick, sword-cane, etc.) has been pushed into the orbit with some force, it may pass through the bony wall and perforate the brain with fatal result.

Treatment. Foreign bodies should be removed by dilatation of their wounds of entrance, or by the formation of a new passage through the conjunctival fornix—and great care should be taken to prevent the onset of inflammation, or to keep it within safe bounds.

Tumours of the Orbit necessarily give rise to exophthalmus, and the motions of the eyeball are generally impaired. Vision often remains good until a very late period, unless the optic nerve becomes involved in the growth, which is a rare occurrence; but, finally, optic neuritis or optic atrophy induces blindness. The upper lid becoming wonderfully enlarged protects the cornea from exposure and consequent ulceration, until at last the great protrusion of the eyeball no longer admits of this, and the cornea is destroyed.

When the tumour has attained a certain size, it may be felt by the tip of the finger passed into the orbit, and some idea of its consistency and mobility can be formed.

In every case, the history, the rapidity of growth, and the general condition of the patient are important items for consideration.

Cysts. Dermoid cysts are amongst those most frequently found. They grow slowly, and finally reach very considerable size, and then bulge out between the

eyeball and margin of the orbit. Pressure upon this protruding part causes it to diminish, while the exophthalmus is at the same time increased, and distinct fluctuation in the protruding part can be felt. The growth of the cyst is unaccompanied by pain or other inconvenience. The contents are generally either serous or honey-like, and, occasionally, hairs and other epidermic formations have been found in them.

Treatment. The cyst should be freely opened at the most prominent point, evacuated by gentle pressure backwards of the eyeball, and the sac syringed out two or three times daily with a solution of carbolic acid (1 in 40), until all discharge has ceased. The opening will then close, while the eyeball will already have returned to its place. If the contents of the cyst are solid or nearly so, it becomes necessary to extirpate it *in toto.* To do this, as in other tumours also, a horizontal incision must be made along the orbital margin through the eyelid, in order that the cavity of the orbit may be reached; or, two perpendicular incisions at either canthus through the upper lid may be made, and the latter turned upwards. With hooks or forceps and scalpel or scissors the cyst wall must then be carefully separated from all adhesions.

Exostoses occur as the result of inflammation of the bone and of periostitis, and are usually of the kind known as ivory exostoses. They spring most commonly from the ethmoid, or from the frontal bone. Their surface is tuberous. Their growth is extremely slow, in many instances commencing in infancy and lasting into advanced life.

Operative interference is only justifiable where the tumour does not start from the roof of the orbit, and where there is reason to think it is attached to the orbital wall by only a narrow base or pedicle. Several instances are on record, in which the growth has become spontaneously separated by necrosis of its pedicle. Beyond the destruction of the eyeball, there is no danger associated with these tumours, even if their growth take an intracranial direction; but they cause serious disfigurement and much pain.

Carcinoma and Sarcoma. The first of these tumours takes its origin in some neighbouring cavity and grows into the orbit; or, it may start from the orbital walls; or, in the retro-bulbar connective tissue. Sarcoma may originate in many different positions, most frequently perhaps in the periosteum and in the connective tissue about the lachrymal gland. These malignant tumours, after destruction of the eyeball by pressure, or by phthisis following ulceration of the cornea, attack the bony walls of the orbit and its surroundings. Many forms of sarcoma, however, are non-malignant.

The early extirpation of the tumour affords, in general, the only prospect of saving the patient's life.

Pulsating Exophthalmus. This title includes a great variety of vascular tumours, the majority of them having their origin within the cranium, while the remainder are truly orbital. Symptoms common to all these processes are:—Exophthalmus; the presence of peculiar bruits which can be heard over the orbit, and usually also over a more or less extensive portion of the skull; and pulsation, apparent in the eyeball or at some point of the orbital

aperture.* The last symptom may occasionally be absent during the whole or part of the progress of the case. The intracranial vascular tumours with which we are most likely to have to deal are:—Aneurism of the ophthalmic artery at its point of origin from the internal carotid; aneurism of the latter vessel; and arterio-venous aneurism from communication of the internal carotid with the cavernous sinus, this latter of traumatic origin. In the orbit the following occur:—True aneurism of any of the arterial branches; diffused or circumscribed traumatic aneurism; arterio-venous aneurism, also of traumatic origin; aneurism per anastomosis; and teliangiectic tumours.

Hæmorrhage is liable to prove fatal in these cases.

Treatment. Ligature of the common carotid affords the best prospect of cure. Digital compression of the vessel has produced cure in some cases.

Exophthalmic Goitre (Graves' Disease, Basedow's Disease).

Symptoms. The three principal symptoms of this disease are:—Increased rapidity of the heart's action, which may reach 200 beats per minute; tumefaction of the thyroid gland; and, exophthalmus. Of these the cardiac symptom is the most constant, and the first to appear; either or both of the others may be wanting.

Von Graefe's Symptom is a very early, tolerably constant, and perfectly pathognomonic one; it consists in an impairment of the consensual movement of the upper lid in association with the eyeball. When, in the normal condition, the globe is rolled downwards, the upper

* Sattler, *Graefe und Sæmisch's Handbuch*, Vol. VI. p. 745.

eyelid falls, and thus its margin is kept throughout in the same relation to the upper margin of the cornea. In Graves' Disease the descent of the upper lid does not take place, or only in an imperfect manner; and, consequently, when the patient looks down, a zone of sclerotic becomes visible between the margin of the lid and the cornea. This symptom is often present prior to any exophthalmus, and may continue after the latter disappears, and is not seen in protrusion of the globe from other causes.

Stellwag's Sign is also very constant. It is an abnormal widening of the palpebral aperture, due to retraction of the upper eyelid, with incompleteness and diminished frequency of the act of involuntary nictitation. It is this gaping of the palpebral aperture which gives the characteristic staring aspect to the patient. Otto Becker has pointed out that, in a majority of the cases, spontaneous pulsation may be seen in the retinal arteries, which are dilated, as are also the veins in a slighter degree. The vision and the condition of the pupil are unaffected by the disease. In some cases there is an increased flow of tears, but most of the patients complain of a dryness of the eyeballs. The sensibility of the cornea is diminished. Ulcers of the cornea are not common, but are more often seen in men than in women, although Graves' Disease is more common in women. The exposure of the eye and dryness of the cornea are, probably, to a great extent, the causes of ulceration when it occurs; but Sattler* inclines to the belief that it is also largely due to paralysis of the nervous supply of the cornea.

* *Graefe und Sæmisch's Handbuch*, Vol. VI. p. 963.

The patients are often hysterical; and even marked psychical disturbances have been noted, such as a peculiar and unnatural gaiety, rapidity of speech, and great irritability; or, on the other hand, extreme depression and even attempts at suicide. Also, loss of memory, and inability to make a mental effort. The motions of the eyeball have in some cases been defective, a fact for which the exophthalmus does not account. The progress of the disease is, as a rule, very chronic, extending over months or years, but liable to fluctuations in the intensity of its symptoms. A few cases have been recorded in which it became fully developed in the course of some hours or days. After a lengthened period and many fluctuations, the symptoms slowly disappear. Occasionally a slight permanent swelling of the thyroid may remain, or a moderate amount of exophthalmus. About 12 per cent. of the cases go from bad to worse, and end fatally from general exhaustion, organic disease of the heart which may have come on, cerebral apoplexy, hæmorrhage from the bowels, or gangrene of the extremities.

Causes. Anæmia and chlorosis are general conditions very often present, as also irregularities of menstruation. Severe illnesses are recorded as having gone before the onset in many cases, and also excessive bodily or mental efforts. Great sexual excitement has been known to be followed by Graves' Disease, and depressing psychical causes are not unfrequent. In many instances, however, the patients have been perfectly healthy, and no cause can be assigned.

The enlargement of the thyroid is due, in the first instance, to dilatation of its vessels, but in a late stage hyper-

trophy of the gland tissue may be produced, and increase of its connective tissue, and even cystic degeneration. The exophthalmus is due to hyperæmia of the retro-bulbar orbital tissues; as is demonstrated by a vascular bruit often present, and the fact that steady pressure on the globe diminishes the protrusion. Hypertrophy of the orbital fat may be found *post-mortem*, but is, doubtless, secondary to the hyperæmia.

The Theory most widely held as to the *Nature of the Disease* represents it as a lesion of the cervical sympathetic, which causes paralysis of the vaso-motor nerves, and consequent goitre, exophthalmus, and pulsation and dilatation of the carotids and retinal arteries; while it causes excited cardiac action by reason of a permanent irritation of the excito-motor nerves of the heart, which also run in the cervical sympathetic. Here the difficulty arises, that two of the chief symptoms are attempted to be explained as the result of paralysis, while the third is said to be due to excitation. The absence, as a rule, of a pupillary symptom is a strong argument against a lesion of the sympathetic. That a state of continuous irritation of the sympathetic should exist is improbable and without proved physiological analogy. With regard to paralysis of the sympathetic causing the goitre and exophthalmos, it is doubtful whether it could do so, for experimental division of the sympathetic has not produced these symptoms in animals, nor have they resulted in clinical cases of paralysis of that nerve in man, although the pupillary symptoms have been marked. *Post-mortem* examination has, no doubt, in a very few instances revealed alterations in the cervical sympathetic, but they

have been of an inconstant nature and were wholly wanting in the vast majority of cases which have been microscopically examined.

These considerations tend to discredit the sympathetic theory.

Professor Sattler, of Erlangen,* has advanced a theory which is worthy of consideration. He assumes a lesion of those circumscribed portions of the vaso-motor centre in the brain which preside over the vaso-motor nerves of the thyroid gland and of the intraorbital tissue, and believes that the great constancy with which enlargement of the thyroid and exophthalmus are present, indicates an intimate local relation of these two portions. He attributes the cardiac symptoms to a lesion of the cardio-inhibitory centre for the pneumogastric. He also regards Graefe's symptom as due to a central lesion, namely, of the co-ordinating centre for the associated motions of the lids and eyeball; while Stellwag's symptom, he believes, as did Stellwag himself, to be due to a lesion of the reflex centres, which are excited by stimuli from the retina and from the sensitive nerves of the cornea and conjunctiva. Sattler's theory derives important support from the experiments of Filehne.† When this observer divided the restiform bodies in their upper quarter, the incision not being carried so deep as to wound the roots of the vagus, yet the functions of the latter nerve became impaired, exophthalmus was pro-

* *Graefe und Sæmisch's Handbuch*, Vol. VI. p. 984, *et seq.*

† Zur Pathogenese der Basedow'schen Krankheit. *Sitzungsber. d. phys. Med. Soc. zu Erlangen*, 14 July, 1879, p. 177. See also *Graefe und Sæmisch's Handbuch*, Vol. VI. p. 1001.

duced, and although the thyroid did not swell, there was vaso-motor paralysis in the ears, thyroid, and anterior part of the neck. Hence Filehne concludes :—that Graves' Disease may be produced by paralysis of certain nerve regions controlled by the medulla oblongata, and that the points traversed in common by the nerve-paths concerned are the restiform bodies: that the exophthalmus and goitre depend on dilatation of the blood vessels: and that the increased heart's action is due to diminution or abolition of tone in the pneumogastric. *Post-mortem* examinations in the human subject are necessary to establish Filehne's theory, but he points out that negative results from some of these would not be fatal to his theory, as the occurrence of functional affections of the central nervous symptom is admitted. Dr. William A. Fitzgerald,* points out, that exophthalmic goitre is frequently complicated by symptoms which are clearly due to a central lesion, such as symmetrical paralysis of the external recti, paralysis of the associated motions of the eyes, and glycosuria.

A very able explanation of the marked preference shown by the symptoms for the right side of the body is given by Dr. W. A. Fitzgerald (*loc. cit.*). Bilateral symmetry (double exophthalmus, and swelling of each half of the thyroid) although not uncommon, is not the rule, especially in the early stages; and, when want of symmetry exists, the preponderance of symptoms is on the right side, the right eye protruded, and the right lobe of the thyroid enlarged. It has occurred to him, that the

* Theory of a Central Lesion in Exophthalmic Goitre. *Dublin Jour. Med. Sc.* March and April, 1883.

extreme constancy of the cardiac symptoms afford a clue to the problem of this preference, for he believes that it, too, is a right-sided symptom, as it is more than probable that it is the right vagus which is chiefly concerned in the inhibition of the heart, and that the left has but little power of the kind. Arloing and Tripier's* experiments, and those of Masoin † and of Meyer ‡ show this, and several cases are on record, in which irritation of the right pneumogastric in man caused marked cardiac inhibition. Fitzgerald thinks, also, that the mode of development of the heart affords an explanation of the supply of that organ by the right rather than by the left vagus; for, soon after its appearance in the embryo, it projects to the right side, where it comes in relationship with the corresponding vagus.

Treatment. A principal part of this consists in the careful regulation of the patient's general health and functions. Freedom from mental anxiety and excitement, regular hours, moderate exercise, and change of air are most important items. In mild forms of the affection, and especially if the anæmia be well marked, iron internally is beneficial, but in severe cases it has the opposite effect. Quinine in moderate doses has been employed with benefit in some cases. Trousseau recommended digitalis in large doses, but its effect must be watched. The beneficial action of iodide of potassium in ordinary goitre has suggested its use in this disease, but under its influence the symptoms are sometimes aggra-

* *Archives de Physiologie*, Tome V. p. 166. 1873.

† *Bull. de l'Acad. Roy. de Med. de Belge*, Tome VI. 3me Serie, p. 4.

‡ Das Hemmungsnervensystem des Herzens, p. 61. 1869.

vated, and it is doubtful whether they are ever relieved by it. The local application of tincture of iodine to the goitre, and on the upper eyelid, are sometimes of use in diminishing the size of the exophthalmus and thyroid swelling. Ergotin internally has been tried, and with advantage in some instances. Sattler warmly recommends a well regulated hydropathic treatment, when the patient is not too excitable. Paroxysms of cardiac palpitations, etc., are best combated with ice applied to the head, heart, and goitre. The sympathetic theory has induced the trial of a galvanic treatment of the cervical sympathetic. In cases where the exophthalmus is so great that the cornea is exposed, even during sleep, it is desirable to perform tarsoraphy (p. 132), and the same operation is indicated when, the disease having subsided, the exophthalmus still remains to a degree which gives the patient a disagreeable expression.

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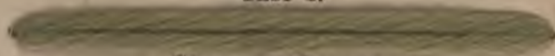

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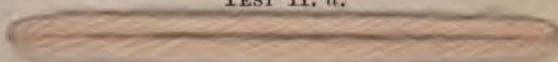

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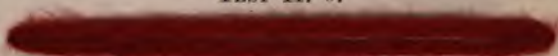

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